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Voluntary

Corrective Measures Plan for Solid Waste Management Unit 21-011(k) at Technical Area 21

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EXECUTIVE SUMMARY

This Voluntary Corrective Measure (VCM) Plan presents the approach for remediation of Solid Waste Management Unit (SWMU) 21-011(k) located within Technical Area (TA) 21 at Los Alamos National Laboratory (LANL or the Laboratory).

SWMU 21-011(k) consists of an inactive NPDES-permitted outfall for treated industrial wastewater from the former wastewater treatment plants (Building 21-35 and 21-157) at TA-21. This includes a 4-in. cast iron drainline and an associated outfall ditch that channeled wastewater to the south rim of DP Canyon and down the north-facing slope of DP Canyon. The effluent was process wastewater generated from the purification of plutonium and contained a variety of radioactive and chemical constituents. SWMU 21-011(k) received industrial effluent from the wastewater treatment plant in Building 21-35 from 1952 until 1967; it received industrial effluent from the wastewater treatment plant in Building 21–257 (that replaced the treatment plant at Building 21-35) from 1967 until the early 1990s when the outfall was left in place.

SWMU 21-011(k) was investigated in 1988 by DOE and by the Laboratory's ER Project in 1992 and 1993. Results of these investigations indicated the presence of significant radionuclide contamination. An interim action (IA) was performed in 1996. Objectives of the IA were to: 1) divert storm water away from the outfall area, and 2) remove a portion of the radionuclide source term from the hillside by excavating and removing the most highly contaminated soils. Approximately 390 yd^3 of radioactively contaminated soil was removed from the site and disposed of at the Laboratory's low-level radioactive waste landfill at TA-54 Area G. Post-excavation radiation survey and soil sampling showed a reduction in gross alpha count levels from greater than 500,000 counts per minute (cpm) to 100,000 cpm. Finally, the IA Completion Report called for the development of a voluntary corrective measure (VCM) to effect a final remedy at the site.

In November 2000, an extensive in situ gamma spectrometry survey was conducted over the entire site, followed by the collection of 48 surface and subsurface soil, tuff and/or sediment samples from eleven locations in March 2001. Twenty-six of the samples were analyzed for waste characterization purposes. The entire data set was used to confirm the location of remaining hotspots in SWMU 21-011(k) and establish a correlation between cesium-137 concentrations, the primary radionuclide at the site, and other radionuclide concentrations in the soil.

Review of the data from the November 2000 and March 2001 sampling events indicate the following:

- the remaining potential contaminants of concern are radionuclides, primarily the relatively short-lived cesium-137 and americium-241;
- none of the contaminated material at the site would be considered hazardous waste upon generation;
- several inorganic chemicals were detected just above background values and will be included in human health and ecological screening assessments to be performed as part of the VCM Completion Report; and
    - completion of the VCM will meet a dose limit of 15 mrem/yr.

The objectives of this VCM are to:

- control the radionuclide contaminant source remaining on the hillside;
- reduce the potential dose associated with the contaminated material; and
    - prevent future contaminant migration.

The Laboratory's ER Project will conduct the following activities to achieve these objectives:

- excavate and dispose of the outfall drainline;
- excavate and solidify contaminated tuff and sediment from hot spots;
- place solidified material in a stabilization cell to be excavated near the center of the SWMU;
- restore the site by placing and compacting approximately 4000 yds^3 of clean fill as a cover over the entire site;
- install storm water run on and runoff controls; and
    - conduct routine site inspections and radiation surveys to ensure the integrity of the remedy.

As the details of this VCM Plan are presented in the body of this document, the following should be kept in mind:

- The site is located on the hillside above DP Canyon where the average slope is 21%-- too steep and impractical for a building site given the abundance of more desirable sites at the Laboratory,
- The planned land use for this site is industrial, with the site under DOE control for at least the next 100 years, although easy access makes the trail user land use scenario more practical, and
- The principle radionuclides contributing to trail user-exposure are cesium-137 (~78% of the dose, half-life 30.17 y) and americium-241 (~13% of the dose, half-life 432.7 y). Over the next 100 years, radioactive decay alone will cause dose rates to decline to 26% of current levels under the recreational trail user scenario assuming pre-remediation average site concentrations.

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APPENDICES

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1.0 INTRODUCTION

This VCM Plan presents the approach for remediating SWMU 21-011(k) located at TA-21, at Los Alamos National Laboratory (Figures 1.0-1 and 1.0-2). SWMU 21-011(k) is an inactive outfall, drainline, and outfall ditch and is listed in Module VIII of the Laboratory's Hazardous Waste Facility Permit (EPA 1990, 01585.2).

The purpose and scope, regulatory history, and rationale for the proposed corrective measure are presented in Section 1. Section 2 presents the site description and operational history, previous field investigations, and results of previous investigations for this SWMU. The basis for cleanup levels and bench scale testing are discussed in Section 3. Section 4 includes the conceptual model, and discussions of characterization and confirmation sampling, cleanup activities, and site restoration. Section 5 presents the estimated types and volumes of waste and the method of management and disposal. Section 6 discusses the proposed schedule and uncertainties. References are listed in Section 7. Appendices are as follows: Appendix A includes acronyms and abbreviations; Appendix B includes the VCM checklist; Appendix C includes the ER Project Standard Operating Procedure 2.01, “Surface Water Site Assessments”; Appendix D includes the ecological checklist, Appendix E includes the estimated costs; Appendix F.1 includes radiological data analysis; Appendix F.2 provides RESidual RADioactivity (RESRAD) inputs and results.

1.1 Purpose and Scope

The objectives of this corrective measure are source reduction/control, dose reduction, and prevention of contaminant migration. To meet these objectives, the Laboratory's Environmental Restoration (ER) Project will conduct the following activities: staged solidification of approximately 500 yd^3 of contaminated soil; reburial of the solidified soil within the SWMU boundary; engineered site restoration; removal of a drainline extending from the wastewater treatment tanks to an outfall that discharges just below the canyon rim at SWMU 21-011(k); and long-term monitoring . In addition, the DOE requires that corrective measures strive to reduce radiation levels to “As Low As Reasonably Achievable” (ALARA) and this VCM incorporates the principle of ALARA (DOE 1990, 58980.1). ALARA features include: isolating radioactive materials from the environment, removal of areas with elevated radioactivity (Figure 1.1-1), and avoidance of risk related to offsite transportation of radioactive materials.

The chemicals of potential concern (COPC) at SWMU 21-011(k) are cesium-137, strontium-90, americium-241 and plutonium-239. The current average dose across the site to a recreational trail user is 7 mrem/yr as shown in Figure 1.1-2. The graph shows that exposure from these radionuclides is dramatically reduced over a 100- to 200-year time period due to radioactive decay. While the site, on average, meets the 15 mrem/yr dose limit for a recreational trail user scenario, there are some areas that exceed the dose limit. Soil from these areas will be removed and solidified. As part of the corrective measure, the engineered restoration will reduce exposure to a trail user below the 15 mrem/yr dose limit over the entire site as is consistent with ALARA. A figure illustrating dose reduction from the corrective action is provided in Appendix F.2.

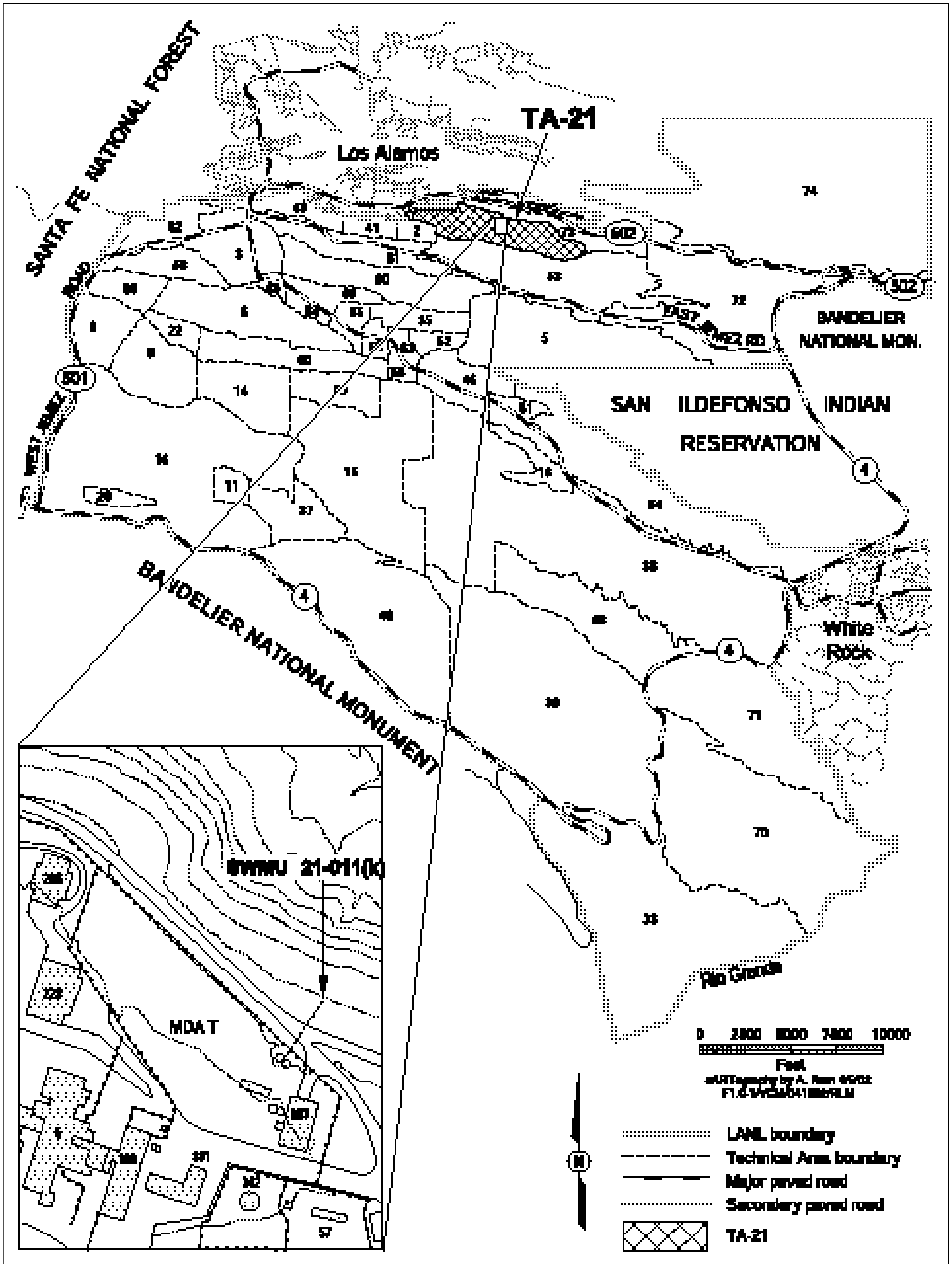

Figure 1.0-1. Location of TA-21 with respect to Laboratory Technical areas and surrounding land holdings.

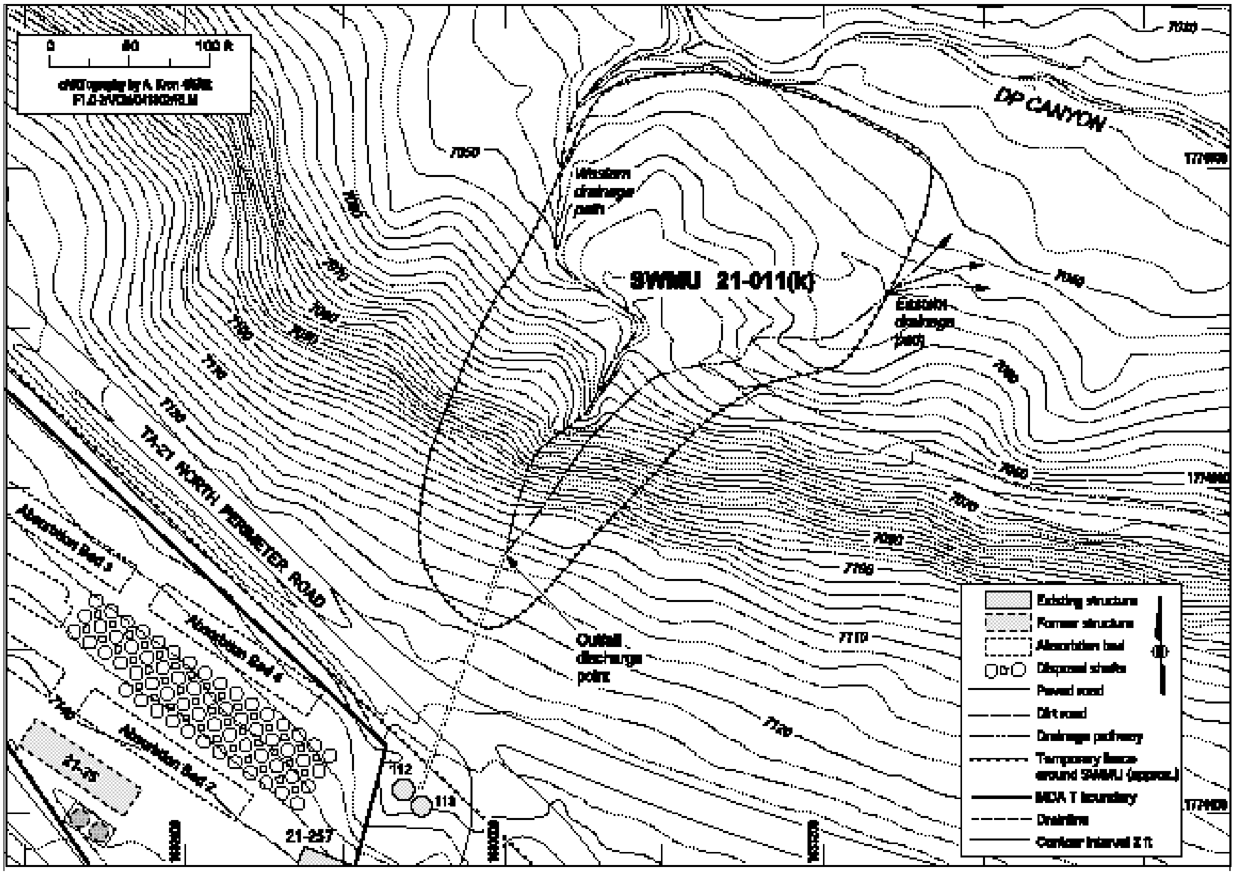

Figure 1.0-2. Location of SWMU 21-011(k) within Laboratory Technical Area 21.

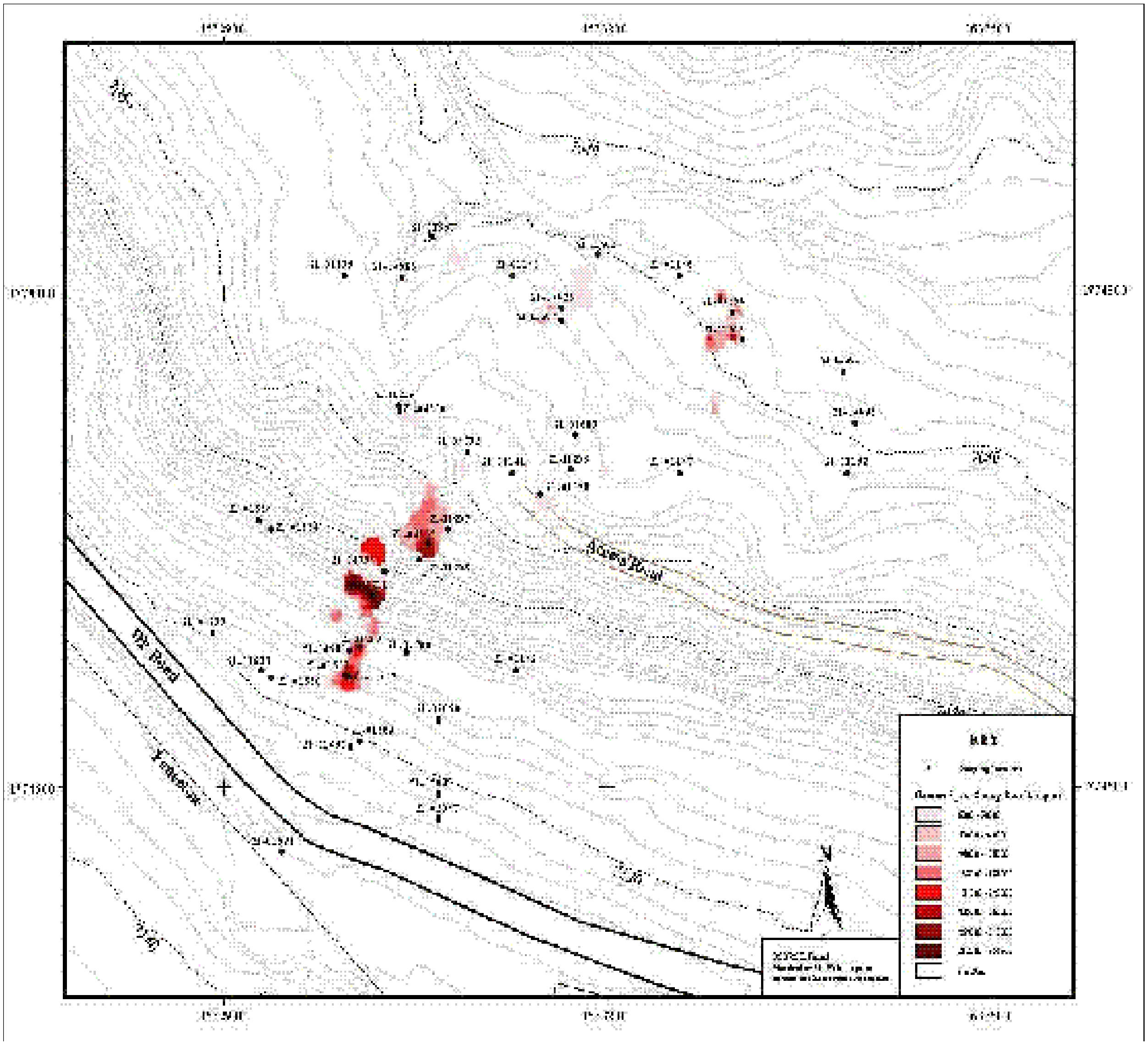

Figure 1.1-1. Areas of elevated activity at SWMU 21-011(k) to be removed and stabilized

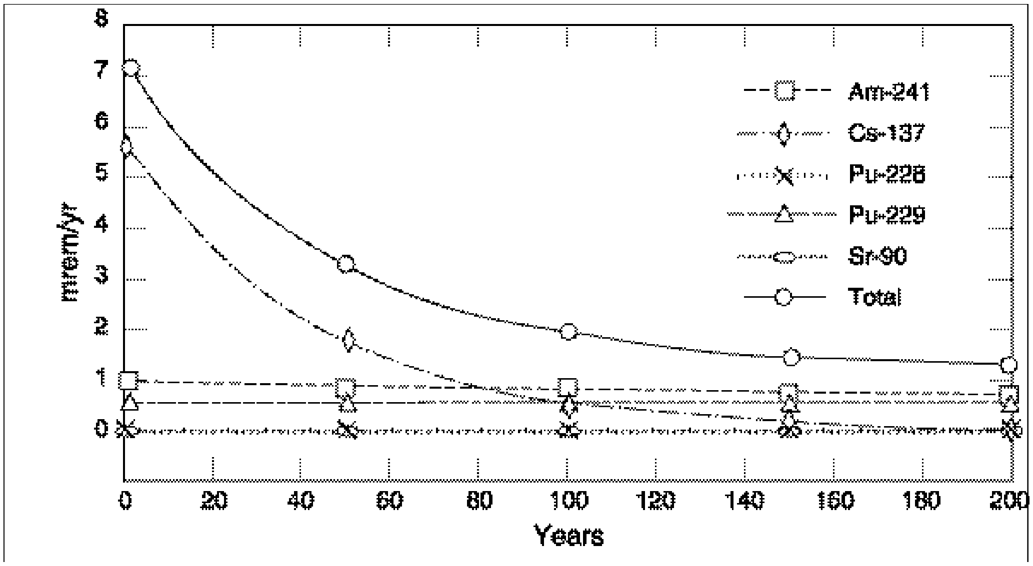

Figure 1.1-2 Dose vs time for trail user scenario at SWMU 21-011(k).

1.2 Regulatory History

The regulatory activities conducted at SWMU 21-011(k) are summarized in Table 1.2-1.

Table 1.2-1
Regulatory Activity for SWMU 21-011(k)

Date	Activity	Document
1988	DOE Reconnaissance Sampling	1994 TA-21 OU RFI Phase Report 1C (LANL 1994, 31591.1)
1992-93	RFI Site Characterization	1994 Addendum to TA-21 Phase Reports 1B and 1C (LANL 1994, 52350.1)
1996/1997	Interim Action	1996 Interim Action Plan for PRS 21-011(k) (LANL 1996, 54790.2); 1997 Interim Action Report for PRS 21-011(k) (LANL 1997, 55648.2)
2001	LANL proposes soil stabilization/solidification to DOE and NMED	Communication Record (LANL 2001, 70217)

1.3 Rationale for Proposed Corrective Measure

SWMU 21-011(k) is located on the north side of DP Mesa on a hillside that leads to DP Canyon. The most northern extent of the slope's toe is within the high water table of the DP Canyon streambed. SWMU 21-011(k) has been identified as the primary source of radionuclide contamination in sediments in the LA Canyon watershed (LANL 1999, 63915). Approximately one-third of a curie of cesium has been identified in the LA Canyon watershed and exists within DP Canyon and LA Canyon. The source of that inventory is SWMU 21-011(k). The existing radionuclide inventory in surface soils, tuff and sediment at the site is one-fourth of a curie of cesium. Because of the site's high potential for erosion (erosion matrix score of 72 out of 100, Appendix C), there is the potential for radionuclides from the site to increase the radionuclide inventory in the LA Canyon watershed. Therefore, remediation of the site is considered a priority by the Laboratory, DOE and the New Mexico Environment Department (NMED).

SWMU 21-011(k) is located on DOE property and will remain under institutional control for at least the next 100 years. Land use for TA-21 is, and will continue to be, industrial under DOE ownership and control. However, the SWMU 21-011(k) site is not a typical industrial site as it is located on a steep hillside that slopes to the bottom of a canyon. Although there are no future plans by Los Alamos County to develop any hiking trails in the canyon, the area is accessible to LANL employees and potentially to the public. Consequently, the trail user scenario is proposed (communication record to NMED, 8/14/01, 70217) and used to screen soil and sediment areas with potentially elevated radionuclide activity exceeding acceptable human health and ecological risk levels.

The proposed VCM activities include the excavation, solidification and reburial of as much as 500 yd^3 of contaminated soil, tuff and sediment; engineered site restoration; and long-term monitoring. In addition, the drainline from Tanks 21-112 and 21-113 to the SWMU boundary will be removed. Soil solidification and reburial is proposed for SWMU 21-011(k) to stabilize elevated concentrations of radionuclides in the soil, sediment, and tuff. Bench-scale solidification testing, using tuff and sediment from SWMU 21-011(k), verified that this technology can be successfully implemented at the site (LANL 2002, 72638). Site restoration will include the placement of a compacted soil layer over the stabilized/solidified material and soil over other areas to accommodate revegetation. The soil layer over the solidified material will provide additional shielding and protection of the stabilized material. The soil layer is designed to provide freeze/thaw protection and a minimum of four feet of cover over the solidified material for the service life of the engineered soil layer. This approach is a cost-effective and proactive remedial alternative, and is preferred over no action, fencing of the site, and excavation and disposal of contaminated material at Area G at TA-54. This VCM approach was developed to protect LANL employees and the public, and to minimize the amount of waste generated. The estimated cost savings of onsite stabilization compared to transportation and disposal at Area G is expected to be approximately $2 million because onsite stabilization eliminates the costs associated with coordination and implementation of transporting low level radiologically contaminated waste over public roadways, through public areas, and disposal at Area G.

2.0 PREVIOUS SITE CHARACTERIZATION AT SWMU 21-011(K)

2.1 Site Description and Operational History

SWMU 21-011(k) was the National Pollution Discharge Elimination System (NPDES)-permitted outfall (NPDES outfall no. EPA050050) for treated industrial wastewater from buildings 21-35 and 21–257, the former industrial wastewater treatment plants (WWTPs) at TA-21. The SWMU consists of a drainline from two industrial wastewater treatment tanks (21-112 and 21-113) that discharged to an outfall ditch, which channeled wastewater to the canyon rim, and down the hillside toward DP Canyon. The ditch is no longer visible; however, a 4-inch cast iron drainline is located approximately 55 feet north of the TA-21 perimeter road in the area where the outfall ditch would have ended. A gently sloping, rocky surface extends from the outfall pipe approximately 30 ft to the canyon rim.

TA-21 is the former plutonium processing facility at LANL. TA-21 began plutonium operations in 1945 and ceased operations in 1978. The first industrial WWTP, 21-35, was activated in 1952 and operated until 1967 when the new industrial WWTP, 21-257, came on line. Both facilities treated wastes from DP West and DP East consisting of liquids remaining after plutonium extraction and processing of radioactive materials for nuclear weapons and aeronautical research projects. The treatment process mixed the raw waste with lime, ferric sulfate, and coagulant aids. The waste was then pumped to a flocculator and on to a settling tank. Settled effluent was pumped through a pressure filter and sampled to verify adequate treatment. If the effluent was determined to be adequately treated, it was pumped to two final holding tanks (21-112 and 21-113). From the tanks, the effluent was piped northeast toward DP Canyon and discharged on the north side of DP Mesa to what is now SWMU 21-011(k). This effluent contained a variety of radioactive and chemical constituents. Discharges of treated industrial wastewater to the outfall were discontinued in the early 1990's. However, approximately 55 gal of partially treated radioactive wastewater was released from holding tank 21-113 in January 2001. The released wastewater was absorbed into the ground within 50 ft of the outfall. Screening of samples from the tank indicated that the water contained radiation levels below those currently within SWMU 21-011(k) (LANL 2001, 72667). Building 21-257 is no longer used for pretreatment of wastewater. The outfall line was permanently plugged as part of the release response (LANL 2001, 72667).

2.2 Previous Field Investigations

SWMU 21-011(k) was sampled during a 1988 DOE Headquarters Environmental Survey of the Laboratory (DOE 1988, 15363). In 1992, SWMU 21-011(k) was characterized as described in the TA-21 Operable Unit (OU) RFI Work Plan with a radiological field survey and collection of soil samples (LANL 1991, 07528.1). Additional characterization consisting of a radiological survey and collection of soil samples was conducted in 1993 due to the elevated radioactivity levels and missed holding times for organic chemicals encountered in the 1992 sampling effort (Figure 2.2-1) (LANL 1994, 52350.1).

2.2.1 1996 Interim Action Soil Removal

In 1996, an IA Plan was prepared (LANL 1996, 54790.2). The IA was conducted in 1996 and 1997 and reported on in the interim action report for Potential Release Site 21-011(k) (LANL 1997, 55648.2).

The IA had two objectives:

- remove a significant portion of the source term from the areas of the outfall exhibiting the greatest levels of radioactivity and,
- install storm water control measures as a best management practice (BMP) to slow the migration of contaminated soil and sediment into the main channel of DP Canyon.

Approximately 390 yd^3 of soil were removed from SWMU 21-011(k) in the 1996 IA (Figure 2.2-2). The results of a post-excavation radiological survey indicated that the soil activity was reduced from greater than 500,000 counts per minute (cpm) to less than 100,000 cpm over the entire upper drainage area. A correlation between cesium-137 concentrations and gross gamma activity was prepared to guide excavation activities during the IA. The 100,000 cpm is equivalent to between 400 and 500 pCi cesium-137/g.

Ten surface samples (from 0 to 6 in.) were collected after removal of 390 yd^3 of soil from areas of highest concentrations in the outfall area (Figure 2.2-2). The samples were analyzed for isotopic plutonium, strontium-90, and by gamma spectroscopy (which includes cesium-137 and americium-241). Analytical results for the ten surface confirmation samples are presented in Table 2.2-1. Analytical results are compared to background or fallout values as presented in "Inorganic and Radionuclide Background Data for Soils, Canyon Sediments and Bandelier Tuff at Los Alamos National Laboratory," (Ryti et al. 1998, 59730.2). Results are also compared to risk-based screening action levels (SAL) that are protective of human health. The SALs used in these comparisons are values presented in "Derivation and Use of Radionuclide Screening Action Levels," (LANL 2001, 69683.1) Americium-241, cesium-137, plutonium-239, and strontium-90 exceeded their respective background values and their respective SALs, as shown in Table 2.2-1.

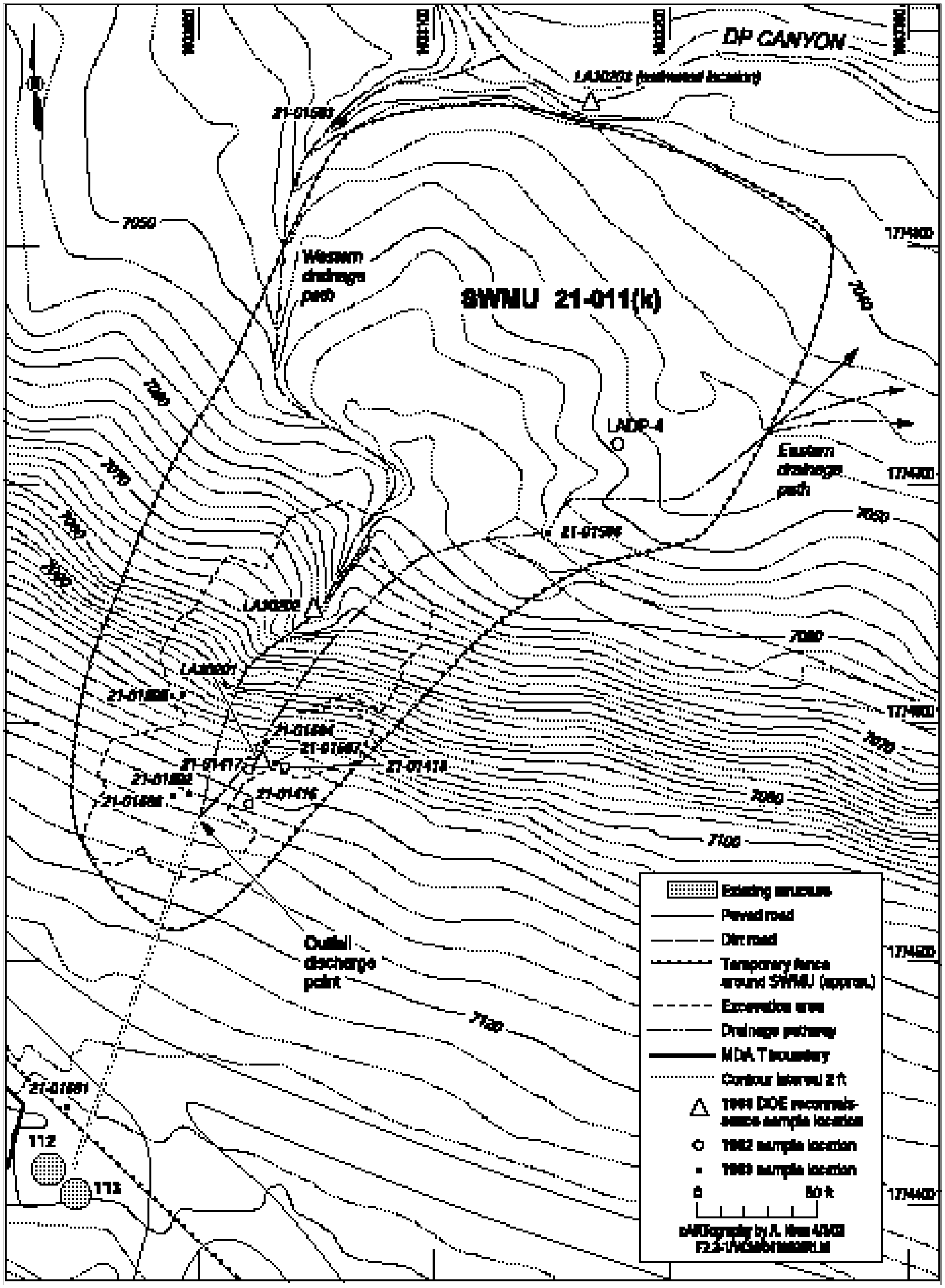

Figure 2.2-1 1988, 1992, and 1993 sampling locations at SWMU 21-011(k)

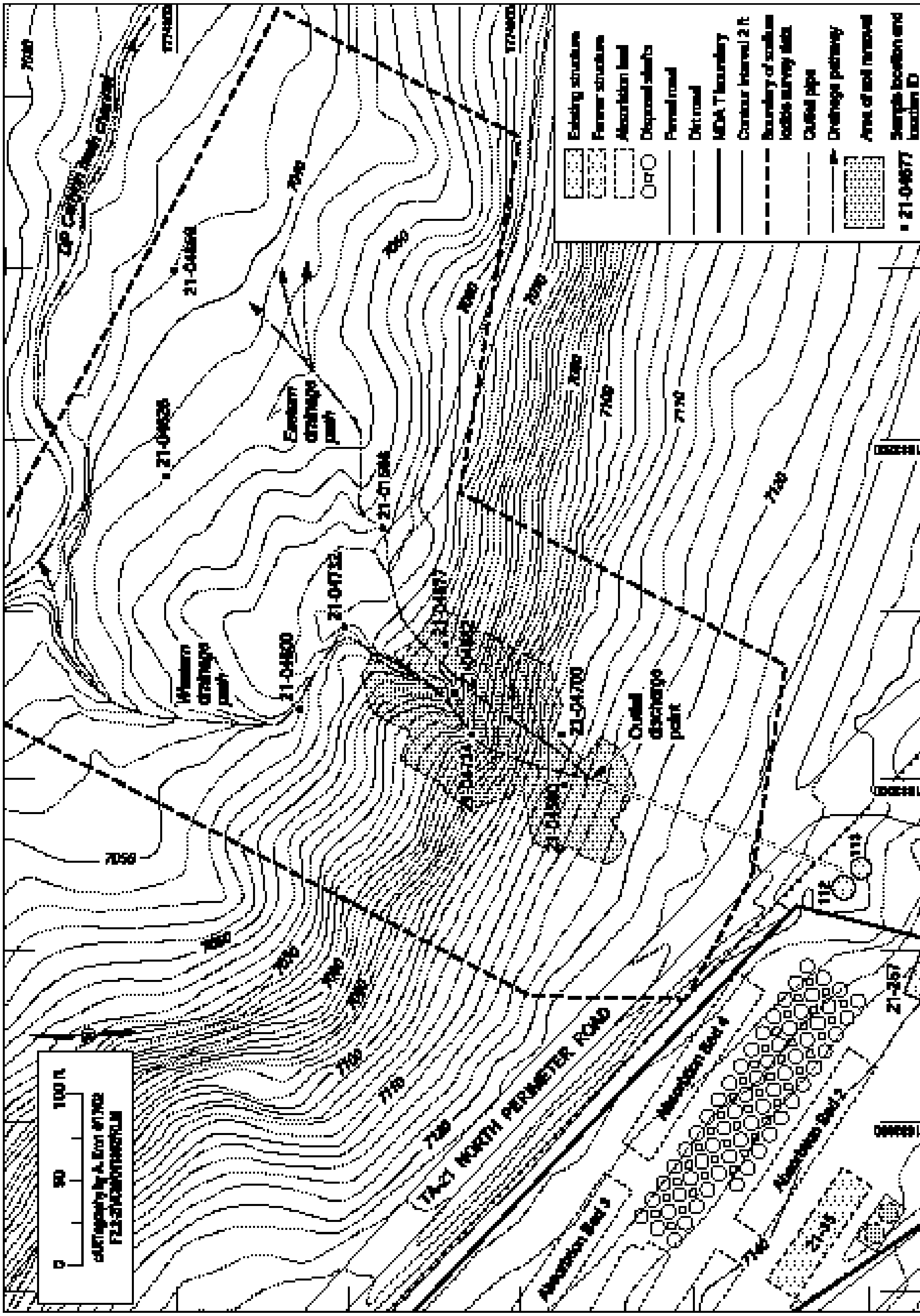

Figure 2.2-2. 1996 interim action soil removal confirmation samples and area of soil removal

Table 2.2-1
1996 Interim Action Confirmation Sample results

Sample ID	Location ID	Depth (ft)	Media	Americium-241 (pCi/g)	Cesium-137 (pCi/g)	Plutonium-238 (pCi/g)	Plutonium-239 (pCi/g)	Strontium-90 (pCi/g)
Soil Fallout Value[a]				**0.013**	**1.65**	**0.023**	**0.054**	**1.31**
SAL				**39**	**5.3**	**49**	**44**	**5.7**
0121-96-0801	21-04734	0-0.5	Soil	10.6	351	0.7838	20.2883	74
0121-96-0802	21-04682	0-0.5	Soil	32.3	621	5.2973	45.959	240
0121-96-0803	21-04600	0-0.5	Soil	125	72.1	7.0991	25.1351	30.7
0121-96-0804	21-04677	0-0.5	Soil	10.5	85.3	1.223	8.72973	33.8
0121-96-0805	21-01598	0-0.5	Soil	0.281	7.05	0.0969	0.79054	1.4
0121-96-0806	21-04732	0-0.5	Soil	2.06	19.7	0.2365	1.8333	7.1
0121-96-0807	21-04700	0-0.5	Soil	601	66.5	27.8919	75.1532	63
0121-96-0808	21-04580	0-0.5	Soil	20.2	877	1.0045	50.95	219
0121-96-0809	21-04856	0-0.5	Soil	2.9	327	0.964	6.2252	24.9
0121-96-0810	21-04626	0-0.5	Soil	14.3	222	4.8694	23.7568	60

[a] Fallout values for soil (Ryti and Longmire 1998, 59730.2)

2.2.2 2000 Chemrad and in Situ Surveys and 2001 Pre-VCM Waste Characterization Sampling.

A walkover gross gamma survey of SWMU 21-011(k) was performed by Chemrad in July 2000. Review of the resulting maps (Figure 2.2-3) showed that the nature and extent of radionuclide contamination at the site had been defined with reasonable confidence and clearly identified hot spots. An in situ gamma survey was conducted at the site in November 2000 to gather more detailed information about the nature and extent (including depth profiles of the radionuclide contamination at the site).

During the in situ gamma surface radiation survey, 650 locations were measured for gross gamma radiation. Approximately 77% of these values were below 50,000 counts per minute (CPM). Approximately 91% of the measurements taken were below 100,000 CPM and 100% of the measurements were below 400,000 CPM. In March 2001, eleven in situ gamma survey locations were selected with concurrence from NMED (LANL 2001, 70217) to conduct depth profiling of the primary radionuclides at the site and to complete waste characterization activities prior to the planned VCM. Two locations with in situ gamma survey results in the low range were chosen for waste characterization sample collection, in addition to four locations exhibiting mid-range survey results, and five locations exhibiting high range survey results. The guidance established for waste characterization sample collection specified that a minimum of one discrete sample was to be collected from each auger hole location. If no elevated radioactivity was detected, then the discrete sample would be collected from the bottom of the auger hole. Two discrete samples were to be collected from any auger hole advanced to a depth of 5 feet or deeper with sample collection intervals based on field screening results and/or the bottom of the hole. Samples submitted for VOC analyses were to be collected from the depth intervals with the highest radioactivity screening results and/or the bottom of the auger hole and not from the top six-inch sample interval. A composite sample, also for waste characterization purposes, was then to be collected from the remaining core at each of the 11 locations.

Waste characterization sample summaries are shown in Table 2.2-2. Field screening data were used to develop an instrument correlation curve (correlating counts with cesium activity levels – See Appendix F), which was presented to NMED in May 2001. The gross gamma survey map and waste sample locations are shown in Figures 2.2-3 and 2.2-4.

Table 2.2-2
2001 Waste Characterization Sample Summaries

Survey ID	Location ID	Depth (ft)	Sample ID	Date/Time	Analytical Suites	Sample Type
256 (Low)	21-11201	0-1	256-0		Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Field Screening
		1-2	MD21-01-0021	3/6/01 10:05	Perchlorate, Gamma Spec, Isotopic Plutonium, Sr-90, TAL Metals, TCLP Metals, TCLP VOCs, TCLP SVOCs, Pesticides, PCBs, VOCs (Encore), Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Discrete
		2-3	256-2		Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Field Screening
		3-4	256-3		Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Field Screening
		4-5	MD21-01-0023	3/6/01 10:30	Perchlorate, Gamma Spec, Isotopic Plutonium, Sr-90, TAL Metals, TCLP Metals, TCLP VOCs, TCLP SVOCs, Pesticides, PCBs, VOCs (Encore), Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Discrete

Table 2.2-3 presents sample results for the one inorganic chemical, mercury, detected above background. Because mercury has no actual background in soil, the required laboratory detection limit of 0.1 mg/kg is the nominal background value. Mercury was detected at one sample location (21-11210, 0.16 mg/kg) at a concentration essentially the same as background and at one sample location in a composite sample (21-11211, 1.8 mg/kg) above the background value (0.1 mg/kg). Mercury was not detected above the SAL (23 mg/kg). The SALs used in these comparisons are derived based on the approach in the human health screening methodology document (LANL 2002, 72639), which is based on guidance in NMED (2000, 68554.1) and EPA (2001, 71466). Two downgradient samples from sample location 21-11211 (locations 21-11208 and 21-11207) had no detects of mercury.

Table 2.2-4 presents sample results for organic chemicals. The analytical results for sample location MD21-0034 were suspect because no organics were detected in samples directly above or below this sample. Therefore, additional samples (MD21-01-0519, 0520, and 0521) were collected from three depths at the same location in October 2001. The analytical results in Table 2.2-3 show organic chemicals were detected sporadically and at low concentrations and were estimated (J) because the reported values were lower than the reporting limits but above method detection limits. No organic chemecals were detected above SAL. The results also confirmed that the VOCs detected in sample MD21-01-0034 were an anomaly.

Table 2.2-3
2001 Waste Characterization Sample Summaries

Survey ID	Location ID	Depth (ft)	Sample ID	Date/Time	Analytical Suites	Sample Type
		0-5	MD21-01-0024	3/6/01 9:55	Perchlorate, Gamma Spec, Isotopic Plutonium, Sr-90, TCLP Metals, TCLP VOCs, TCLP SVOCs, Pesticides, PCBs, Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Waste Composite
352 (Mid)	21-11202	0-1	MD21-01-0025	3/6/01 11:11	Perchlorate, Gamma Spec, Isotopic Plutonium, Sr-90, TAL Metals, TCLP Metals, TCLP VOCs, TCLP SVOCs, Pesticides, PCBs, VOCs(Encore), Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Discrete
		1-2	352-1		Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Field Screening
		2-3	352-2		Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Field Screening
		3-4	352-3		Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Field Screening
		4-5	MD21-01-0022	3/6/01 12:33	Perchlorate, Gamma Spec, Isotopic Plutonium, Sr-90, TAL Metals, TCLP Metals, TCLP VOCs, TCLP SVOCs, Pesticides, PCBs, VOCs (Encore), Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Discrete
		0-5	MD21-01-0026	3/6/01 12:20	Perchlorate, Gamma Spec, Isotopic Plutonium, Sr-90, TCLP Metals, TCLP VOCs, TCLP SVOCs, Pesticides, PCBs, Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Waste Composite
67 (Low)	21-11203	0-1	67-0		Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Field Screening
		1-2	MD21-01-0027	3/7/01 9:31	Perchlorate, Gamma Spec, Isotopic Plutonium, Sr-90, TAL Metals, TCLP Metals, TCLP VOCs, TCLP SVOCs, Pesticides, PCBs, VOCs (Encore), Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Discrete
		2-3	67-2		Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Field Screening
		3-4	67-3		Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Field Screening
		4-5	MD21-01-0029	3/7/01 9:44	Perchlorate, Gamma Spec, Isotopic Plutonium, Sr-90, TAL Metals, TCLP Metals, TCLP VOCs, TCLP SVOCs, Pesticides, PCBs, VOCs (Encore), Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Discrete
		0-5	MD21-01-0028	3/7/01 9:36	Perchlorate, Gamma Spec, Isotopic Plutonium, Sr-90, TCLP Metals, TCLP VOCs, TCLP SVOCs, Pesticides, PCBs, Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Waste Composite
331 (Mid)	21-11204	0-1	331-0		Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Field Screening
		1-2	331-1		Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Field Screening
		2-3	MD21-01-0030	3/7/01 10:18	Perchlorate, Gamma Spec, Isotopic Plutonium, Sr-90, TAL Metals, TCLP Metals, TCLP VOCs, TCLP SVOCs, Pesticides, PCBs, VOCs (Encore), Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Discrete

Table 2.2-3

Survey ID	Location ID	Depth (ft)	Sample ID	Date/Time	Analytical Suites	Sample Type
		3-4	331-3		Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Field Screening
		4-5	MD21-01-0031	3/7/01 10:27	Perchlorate, Gamma Spec, Isotopic Plutonium, Sr-90, TAL Metals, TCLP Metals, TCLP VOCs, TCLP SVOCs, Pesticides, PCBs, VOCs (Encore), Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Discrete
		0-5	MD21-01-0032	3/7/01 10:23	Perchlorate, Gamma Spec, Isotopic Plutonium, Sr-90, TCLP Metals, TCLP VOCs, TCLP SVOCs, Pesticides, PCBs, Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Waste Composite
122 (Mid)	21-11205	0-1	122-1		Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Field Screening
		1-2	MD21-01-0033	3/7/01 12:29	Perchlorate, Gamma Spec, Isotopic Plutonium, Sr-90, TAL Metals, TCLP Metals, TCLP VOCs, TCLP SVOCs, Pesticides, PCBs, VOCs (Encore), Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Discrete
		2-3	122-2		Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Field Screening
		3-4	122-3		Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Field Screening
		4-5	MD21-01-0034	3/7/01 12:57	Perchlorate, Gamma Spec, Isotopic Plutonium, Sr-90, TAL Metals, TCLP Metals, TCLP VOCs, TCLP SVOCs, Pesticides, PCBs, VOCs (Encore), Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Discrete
		0-5	MD21-01-0035	3/7/01 12:38	Perchlorate, Gamma Spec, Isotopic Plutonium, Sr-90, TCLP Metals, TCLP VOCs, TCLP SVOCs, Pesticides, PCBs, Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Waste Composite
496 (Mid)	21-11206	0-1	MD21-01-0036	3/8/01 10:30	Perchlorate, Gamma Spec, Isotopic Plutonium, Sr-90, TAL Metals, TCLP Metals, TCLP VOCs, TCLP SVOCs, Pesticides, PCBs, VOCs (Encore), Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Discrete
		1-2	496-1		Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Field Screening
		2-3	496-2		Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Field Screening
		3-4	496-3		Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Field Screening
		4-5	MD21-01-0037	3/8/01 10:52	Perchlorate, Gamma Spec, Isotopic Plutonium, Sr-90, TAL Metals, TCLP Metals, TCLP VOCs, TCLP SVOCs, Pesticides, PCBs, VOCs (Encore), Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Discrete
		0-5	MD21-01-0038	3/8/01 22:44	Perchlorate, Gamma Spec, Isotopic Plutonium, Sr-90, TCLP Metals, TCLP VOCs, TCLP SVOCs, Pesticides, PCBs, Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Waste Composite

Table 2.2-3

Survey ID	Location ID	Depth (ft)	Sample ID	Date/Time	Analytical Suites	Sample Type
547 (High)	21-11207	0-1	MD21-01-0039	3/8/01 11:41	Perchlorate, Gamma Spec, Isotopic Plutonium, Sr-90, TAL Metals, TCLP Metals, TCLP VOCs, TCLP SVOCs, Pesticides, PCBs, VOCs (Encore), Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Discrete
		1-1.5	547-1		Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Field Screening
		0-1.5	MD21-01-0040	3/8/01 11:41	Perchlorate, Gamma Spec, Isotopic Plutonium, Sr-90, TCLP Metals, TCLP VOCs, TCLP SVOCs, Pesticides, PCBs, Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Waste Composite
554 (High)	21-11208	0-1	554-0		Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Field Screening
		1-2	MD21-01-0041	3/8/01 13:09	Perchlorate, Gamma Spec, Isotopic Plutonium, Sr-90, TAL Metals, TCLP Metals, TCLP VOCs, TCLP SVOCs, Pesticides, PCBs, VOCs (Encore), Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Discrete
		2-3	554-2		Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Field Screening
		3-4	554-3		Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Field Screening
		4-5	MD21-01-0042	3/8/01 13:49	Perchlorate, Gamma Spec, Isotopic Plutonium, Sr-90, TAL Metals, TCLP Metals, TCLP VOCs, TCLP SVOCs, Pesticides, PCBs, VOCs (Encore), Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Discrete
		0-5	MD21-01-0043	3/8/01 13:49	Perchlorate, Gamma Spec, Isotopic Plutonium, Sr-90, TCLP Metals, TCLP VOCs, TCLP SVOCs, Pesticides, PCBs, Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Waste Composite
595 (High)	21-11209	0-1	MD21-01-0044	3/9/01 9:35	Perchlorate, Gamma Spec, Isotopic Plutonium, Sr-90, TAL Metals, TCLP Metals, TCLP VOCs, TCLP SVOCs, Pesticides, PCBs, VOCs(Encore), Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Waste Composite
583 (High)	21-11210	0-1	MD21-01-0045	3/9/01 9:55	Perchlorate, Gamma Spec, Isotopic Plutonium, Sr-90, TAL Metals, TCLP Metals, TCLP VOCs, TCLP SVOCs, Pesticides, PCBs, VOCs (Encore), Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Waste Composite
564 (High)	21-11211	0-1	MD21-01-0069	3/9/01 10:20	Perchlorate, Gamma Spec, Isotopic Plutonium, Sr-90, TAL Metals, TCLP Metals, TCLP VOCs, TCLP SVOCs, Pesticides, PCBs, VOCs (Encore), Gross alpha/beta, Gross gamma, Cesium-137, Americium-241	Waste Composite
			MD21-01-0046	3/12/01 10:30	Perchlorate, Gamma Spec, Isotopic Plutonium, Sr-90, TAL Metals, Pesticides, PCBs, VOCs	Field QC
			MD21-01-0047	3/6/01 8:30	VOCs	Field QC

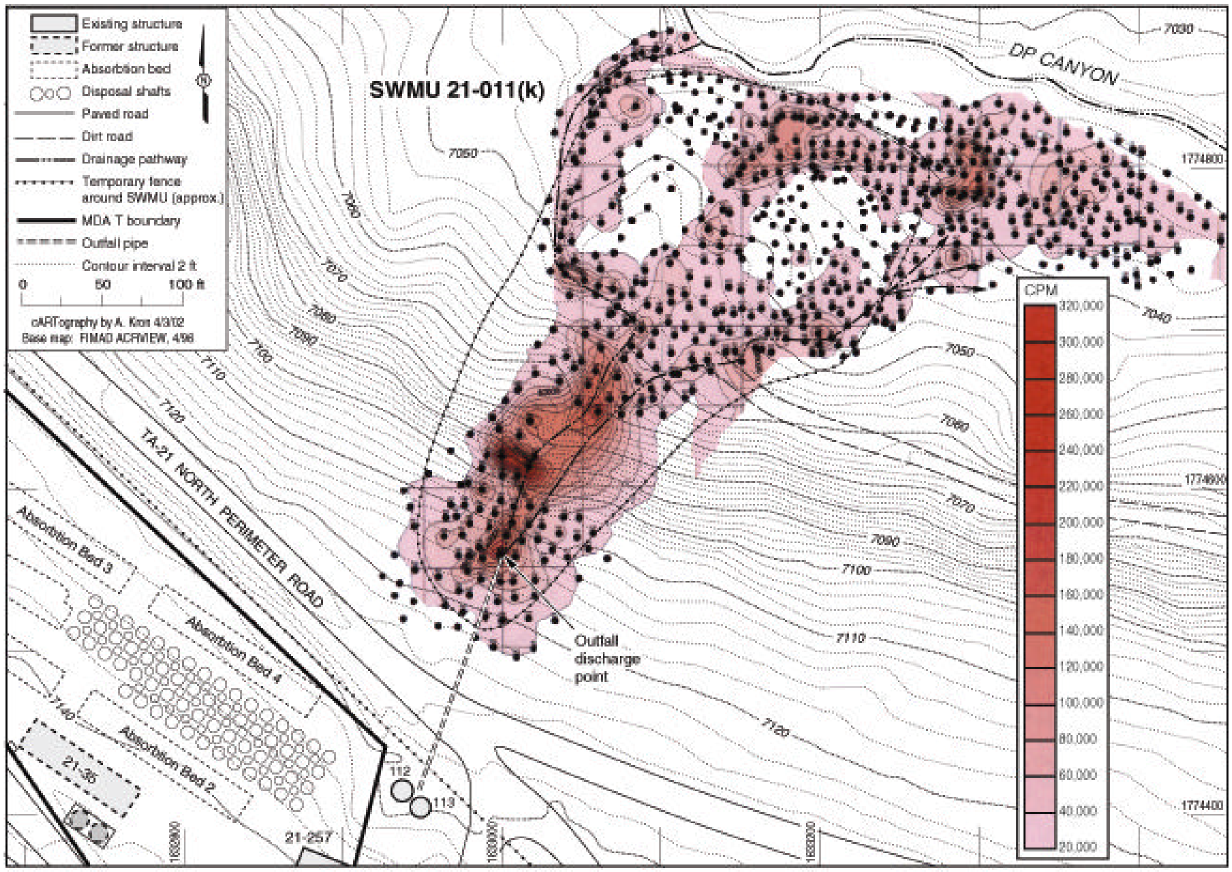

Figure 2.2-3 Gross gamma radiation levels above background at SWMU 21-011(k)

Table 2.2-3
2001 Pre-VCM Characterization Sample Inorganic Chemical Concentrations

Sample ID	Location ID	Depth Interval (ft)	Mercury (mg/kg)
Soil Background[a]			**0.1**
	SAL		**23**
MD21-01-0027	21-11203	1-2	0.0078 (J)[b]
MD21-01-0030	21-11204	2-3	0.0081 (J)
MD21-01-0044	21-11209	0-1	0.14 (J)
MD21-01-0045	21-11210	0-1	0.16
MD21-01-0069	21-11211	0-1	1.8

a Based on required laboratory detection limit for mercury (Ryti et al. 1998, 59730.2)

b "J" Indicates estimated value between the method detection limit (MDL) and the practical quantitation limit (PQL).

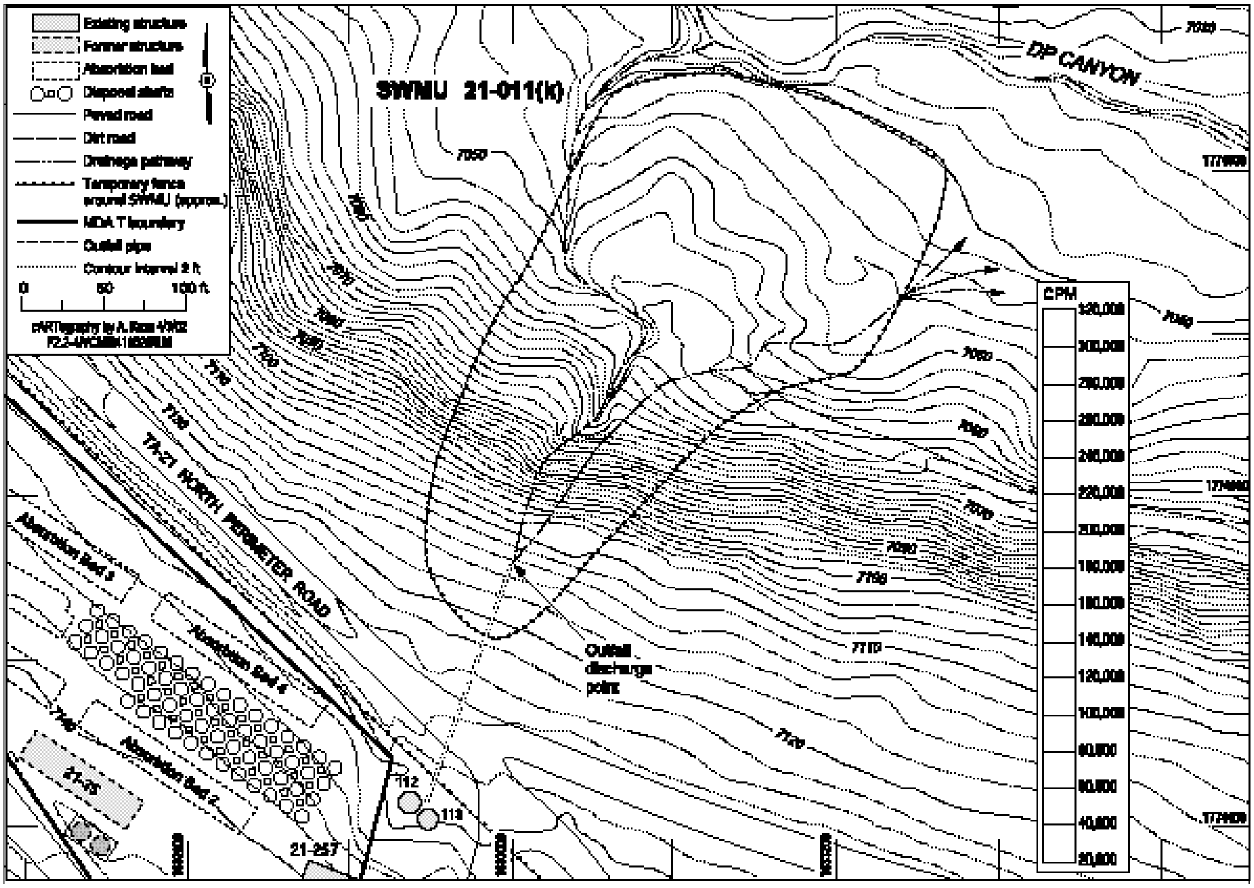

Figure 2.2-4 Pre-VCM Waste Characterization sampling locations

Table 2.2-4
2001 Pre-VCM Characterization Sample Organic Chemical Concentrations

Sample ID	Location Id	DeptH Interval	4,4'-DDT (mg/kg)	Acetone (mg/kg)	Methylene chloride (mg/kg)	4-Isopropyltoluene [1](mg/kg)	2-Hexanone [2] (mg/kg)	Trichloroethylene (mg/kg)	4-methyl-2-pentane (mg/kg)	Toluene (mg/kg)
SAL			1.7	1600	8.9	160	7300		3.6	180
MD21-01-0025	21-11202	0-1 ft	0.00044 (J)	- [a]	-	-	-	-	-	-
MD21-01-0022	21-11202	4-5 ft	-	0.013 (J)	-	0.0073	-	-	-	-
MD21-01-0033	21-11205	1-2 ft	0.00057 (J)	-	-	-	-	-	-	-
MD21-01-0034	21-11205	4-5 ft	-	0.050	0.072	0.026	-	-	-	-
MD21-01-0036	21-11206	0-1 ft	0.00039 (J)	-	-	-	-	-	-	-
MD21-01-0039	21-11207	0-1 ft	-	-	0.0076	-	-	-	-	-
MD21-01-0041	21-11208	1-2 ft	-	-	0.0082	-	-	-	-	-
MD21-01-0042	21-11208	4-5 ft	-	-	0.0092	-	-	-	-	-
MD21-01-0044	21-11209	0-1 ft	0.00069 (J)	-	-	-	-	-	-	-
MD21-01-0045	21-11210	0-1 ft	0.00051 J	-	-	-	0.026 (J)	-	-	-
MD21-01-0069	21-11211	0-1 ft	0.00088 J	0.021 (J)	-	-	-	-	-	-
MD21-01-0519	21-11205	0-1 ft	-	-	-	-	-	-	-	-
MD21-01-0520	21-11205	4-5 ft	-	-	-	-	-	-	-	-
MD21-01-0521	21-11205	1-2 ft	-	-	-	-	-	1.8(J)	-	1.0(J)

[1]isopropylbenzene was used as a surrogate for isopropyltoluene (EPA 2000, 68410)

[2] methyl ethyl ketone used as a surrogate for 2-hexanone (EPA 2000, 68410)

[3] "-" denotes not detected.

[4] "J" denotes estimated value between the MDL and PQL

Table 2.2-5 presents the radionuclide values greater than fallout values for americium-241, cesium-137, plutonium-239, and strontium-90. Of these radionuclides, cesium-137, plutonium-239, and strontium-90 were detected at concentrations greater than their respective SALs. Cesium-137 was detected above its SAL in ten samples, strontium-90 was detected above its SAL in eight samples, and plutonium-239 was detected above its SAL in two samples.

Table 2.2-5
2001 Pre-VCM Waste Characterization Sample
Radionuclide Concentrations above Background/Fallout

Sample ID	Location ID	Depth (ft)	Cesium-137 (pCi/g)	Strontium-90 (pCi/g)	Plutonium-239 (pCi/g)	Americium-241 (pCi/g)	Plutonium-238 (pCi/g)
Fallout Soil Valuea			**1.65**	**1.31**	**0.054**	**0.013**	**0.023**
SAL			**5.3**	**5.7**	**44**	**39**	**49**
MD21-01-0021	21-11201	1-2	1.43	1.7	0.122	-[b]	0.034
MD21-01-0022	21-11202	4-5	1.67	-	0.094	-	-
MD21-01-0025	21-11202	0-1	40.5	7.1	1.93	2.2	0.293
MD21-01-0027	21-11203	1-2	8.7	2.56	0.37	-	0.31
MD21-01-0029	21-11203	4-5	1.03	-	0.036	-	0.048
MD21-01-0030	21-11204	2-3	2.6	0.9	0.111	-	0.074
MD21-01-0033	21-11205	1-2	150	26.1	13.2	13.7	0.63
MD21-01-0034	21-11205	4-5	3.78	1.02	1.01	6.9	0.21
MD21-01-0036	21-11206	0-1	29	3.75	1.18	-	0.122
MD21-01-0037	21-11206	4-5	1.52	0.51	0.118	-	-
MD21-01-0039	21-11207	0-1	109	30.8	11.3	7.9	0.74
MD21-01-0041	21-11208	1-2	445	132	20.5	19	1.64
MD21-01-0042	21-11208	4-5	56.7	15.8	4.33	21	1.2
MD21-01-0044	21-11209	0-1	246	103	32.6	14.9	0.8
MD21-01-0045	21-11210	0-1 ft	343	83	51.2	22.3	0.95
MD21-01-0069	21-11211	0-1 ft	690	268	59.2	32.5	1.02

[a] Based on values in soil only (Ryti and Longmire 1998, 59730.2)
[b] "-" denotes not detected

Summary

The 1996 post-IA sample data, the 2000 Chemrad and in situ gamma survey data, and the 2001 pre-VCM waste characterization data confirm that radionuclides are the COPCs driving risk at the site, and identified areas with elevated activities that will be addressed during this VCM. The data show a clear boundary between the northern edge of SWMU 21-011(k) and the DP Canyon stream channel and confirm that radionuclides have not migrated to the channel since the completion of the 1996 IA.

3.0 BASIS FOR CLEANUP LEVELS

The land use scenario considered most appropriate for derivation of cleanup levels is recreational trail use. The dose-based radiological cleanup levels for the trail user scenario are derived using RESRAD, as shown in Appendix F.2. Development of this scenario leads to the dose-based single soil radionuclide guidelines (SSRG) provided in Table 3.0-1.

Table 3.0-1
SSRGS derived For the recreational trail user scenario

Radionuclide	SSRG (pCi/g)
Americium-241	427
Cesium-137	294
Plutonium-238	496
Plutonium-239	447
Strontium-90	8,288

Because SWMU 21-011(k) has a mixture of radionuclides present at the site, the SSRGs do not apply independently. To account for the mixture of radionuclides at the site and uncertainty inherent in the estimates, a decision was made to reduce the SSRG for cesium-137 to a target level of 150 pCi/gm. This target level meets the goal for cesium-137 as well as the other radionuclide COPCs because of the collocation within the SWMU.

Areas of elevated activity are present on site however, where the sum of ratios may approach or exceed unity. These areas are the focus of the corrective measure. Soil will be removed from these locations with the goal of meeting the target levels. In addition, an elevated activity criterion in DOE Order 5400.5 (Chapter 4, section 4.A.1) must be satisfied once these areas have been remediated (DOE 1990, 58980.1). The DOE Order 5400.5 criterion is listed in the Appendix A glossary and is further discussed in Appendix F.

The areas of elevated concentrations were identified based on 1999 and 2001 analytical data and 2000 gamma surveys. These results were used to generate volume estimates that are presented in Appendix F1.

Based on a preliminary assessment of potential impacts to site ecology, corrective measures for protection of human health will also be protective of ecological receptors. A complete Ecological Screening Assessment will be presented in the VCM Completion Report.

4.0 PROPOSED CORRECTIVE MEASURE

4.1 Conceptual Model

SWMU 21-011(k) is an outfall where industrial wastewater was discharged from holding tanks 21-112 and 21-113 onto the north side of DP Mesa. The wastewater liquids remaining after the plutonium extraction contained a variety of radioactive and chemical constituents. The COPCs in the effluent would have been largely in solution, but because of their geochemical characteristics, most of these would have adsorbed onto sediment particles or organic colloids (Langmuir 1997, 56037).

COPCs in effluent that infiltrated into the colluvial slope would have preferentially adsorbed to organic matter in the soil and finer-grained particles because of their greater surface area and, in the case of clay minerals and solid organic matter, their high-cation exchange capacity. COPCs in effluent that infiltrated into the toe of the slope would have encountered mainly coarse-grained sediment. Adsorption of significant amounts of the radionuclides may have been onto small amounts of other components within the coarse-grained sediment (e.g., organic matter, iron oxide coatings on larger grains, or clay particles adhered to larger grains).

During the period of effluent releases, contaminant inventories would have built up incrementally. Later development of a gully on the slope below SWMU 21-011(k) allowed erosion of some of the contaminated sediments into the DP Canyon channel (LANL 1999, 63915).

The surface water, air, and mass wasting transport pathways do not contribute significantly to current contaminant transport. The site is currently protected by stormwater run-on controls such that the only water contacting the contaminated soil is rain or snow falling directly on the SWMU. Therefore, contaminant transport via stormwater or snowmelt runoff and infiltration has been controlled by BMPs. The SWMU is vegetated and portions of it covered with plant litter, thereby minimizing any contaminant transport via wind and fugitive dust. Contaminant transport via mass wasting is not likely because the slope is quite stable with no new evidence of erosion since the stormwater run-on controls were installed in 1996 and upgraded in 1999.

There are two complete pathways for potential human contact. The first is direct radiation from gamma emitting COPCs such as cesium-137. The second is direct contact with contaminated soil.

The ecological conceptual site model and rationale are presented in Part C of the ecological scoping checklist in Appendix D. The ecological model depicts the potential transport and exposure pathways of significance to terrestrial receptors. In general, exposure pathways to terrestrial receptors can occur through air (inhalation or deposition of particulates), surface soil (root uptake and rain splash on plants, food web transport via plants and/or animals, incidental ingestion of soil/sediment, dermal contact with soil/sediment, and external radiation), and surface water (root uptake and rain splash on plants, food web transport to plants and animals, incidental ingestion of soil/sediment/surface water, dermal contact with soil/sediment, and external radiation from soil/sediment). The Canyons Focus Area will address the stream channel as part of the evaluation of sediment and surface and alluvial ground water in DP Canyon.

4.2 Supplemental Sampling

A target maximum activity level has been calculated for cesium-137 of 150 pCi/g. The derivation of this target level is in Appendix F.1. The discussions that follow in all parts of section 4.3 Surveys and Sampling describe screening and sampling for confirmation of field instrument accuracy and for planning excavation activities in greater detail in the western drainage.

4.3 Surveys and Sampling

Gross gamma surveys will be performed in the field to guide the excavation of materials with elevated activities at the site. This will be supplemented by screening for cesium-137 in an on-site trailer using single-channel or multi-channel analysis with a sodium iodide scintillation detector. Due to the variation of instrument efficiencies it will be necessary to collect samples for fixed laboratory analysis to validate the screening measurements for cesium-137. In the western drainage, a PG-2 analyzer will be used to screen and guide excavation, as described in Section 4.3.2.

4.3.1 Radiological Sampling

Gross gamma measurements and cesium-137 measurements made in the on-site trailer during the VCM will guide excavation in all areas to be remediated except for the drainage in the western portion of the site. A total of six soil or tuff samples will be collected from areas of the site that have count rates less than the 150,000 cpm level as defined in the gross gamma survey map prepared in FY01 (Figure 2.2-3). The samples will be chosen in this manner to ensure accuracy of the screening within the range of activities from background to roughly 150 pCi/g cesium-137. Samples will be screened in the field with a gamma screening instrument to insure a range of observed count rates are collected. Accuracy at higher soil activity levels is not needed since the soil and tuff will be excavated and solidified. All six samples will be submitted to American Radiation Services (ARS) for gamma spectrometry and gross alpha, beta and gamma radiation screening for Department of Transportation (DOT) shipping purposes and for fixed lab gamma spectrometry. The samples used for DOT shipping purposes will be returned to the site and used as benchmarks for the validation of on-site measurements. This sampling event will take place two months prior to removal and stabilization activities to ensure that data are available when needed. Good correlations could not be documented for plutonium-239 or americium-241 from the FY01 gross gamma survey in the western drainage using gamma spectrometry or gross gamma (Appendix F.1). Therefore, americium-241 screening in an on-site trailer will occur using a single channel analyzer with an Eberline PG-2 sodium iodide detector. Activity levels for plutonium-238/239 are below the SSRG (447 pCi/g) required for the recreational trail user scenario and, therefore, do not need to be correlated to the field instruments.

4.3.2 Western Drainage Pre-Excavation Screening

There is a lack of data throughout the western drainage to accurately identify areas to be excavated. Of the five sample locations with analytical data, two are essentially co-located. Only one sample, 21-11205, (Figure 2.2-3) has data at depth sufficient for volume characterization. As part of the pre-excavation radiological characterization described in Section 4.3.1, samples will be collected from up to nine locations and sampled every foot until auger refusal or a total depth of 5 ft is reached. The samples will be screened with an Eberline PG-2/single channel analyzer in the field trailer to identify areas of elevated activity in sediments in the drainage. Aliquots of the samples will also be sent to ARS for gamma spectroscopy, and to the fixed laboratory for analysis of gamma spectroscopy (includes cesium-137 and americium-241) and additional analyses of isotopic plutonium and strontium-90. This sampling event will take place two months prior to removal and stabilization activities to ensure the data are available when needed to identify areas to be excavated.

4.4 Technology Evaluation/Literature Search

In December 2001, Argonne National Laboratory's Environmental Assessment Division (ANL-EAD) evaluated potential remediation technologies for the treatment of soils with elevated levels of cesium-137 and strontium-90 in support of the VCM at SWMU 211-011(k). The VCM requires that the mobility of the radionuclides of concern be reduced, the site be returned to a condition safe for potential human recreational use, and that it be acceptable from an ecological risk evaluation perspective.

The technology evaluation for SWMU 21-011(k) considered only those remedial technologies that have demonstrated an ability to separate, concentrate or immobilize radionuclide constituents in a soil matrix. In addition, the maturity of the potential remedial technology was also considered.

The data and supporting information for the technology evaluation were obtained from the following sources:

- Federal Remediation Technologies Round Table (FRTR) Remediation Technologies Screening Matrix, www.frtr.gov/matrix2/top_page.html,
- ANL-U.S. DOE TechCon Data Base,
- Internet searches, and
- ANL-DOE personnel.

After a review of the FRTR Remediation Technologies Screening Matrix and a search of the sources listed above, five remedial technologies with the potential of treating the radionuclides of concern in a soil matrix were identified. These technologies include the following:

- Stabilization/solidification
- Electrokinetic separation
- Chemical extraction
- Phytoremediation
- Soil washing

Stabilization/solidification was rated the highest of all the potential remedial technologies evaluated for radionuclides in a soil matrix. Stabilization/solidification remedial technologies immobilize radionuclides by physically enclosing or chemically binding within the soil matrix. This i

s a mature technology with demonstrated success with radionuclides. The long-term performance and durability of the stabilized soil can be predicted on the basis of currently available models.

Electrokinetic separation was listed in the FRTR Remediation Technologies Screening Matrix as having the potential to remove radionuclides from a soil matrix. In many cases, radionuclides act as heavy metals. Electrokinetic separation technologies employ a DC current between electrodes that mobilizes metal ions towards and causes them to deposit or plate onto, the electrodes. This technology is not applicable to SWMU 21-011(k) for two reasons. First, cesium-137 ions would migrate to the electrodes, but unlike heavy metals, would not plate to the electrode. This would create areas of localized concentrations of cesium-137 that would have to be removed. Second, for this technology to succeed, constant soil moisture would have to be maintained, which would be difficult to achieve in an arid environment. Electrokinetic separation was removed from consideration for these reasons.

Chemical extraction was listed in the FRTR Remediation Technologies Screening Matrix as having the potential to remove radionuclides from a soil matrix. This separation technology utilizes either a solvent or acid to extract heavy metals from soils sediments or sludge. This technology tends to be equipment intensive and creates residual waste streams that must be managed. Given the small quantity of material to be treated at SWMU 21-011(k) and the limited track record of this technology on radionuclide-containing soils, this technology was removed from consideration.

Phytoremediation has been successfully employed to treat soils contaminated with radionuclides on both a pilot and full-scale basis. It has been demonstrated that several species of plants bioaccumulate cesium-137 and strontium-90. Successful deployment of a phytoremediation system depends largely on soil characteristics. Generally, the lower the clay content of the soils, the greater the bioavailability of cesium for plant uptake. This remedial approach has two potential disadvantages. First, the biomass would have to be continually harvested until the site cleanup criteria are met, and secondly, the biomass disposal may be problematic because of the radioactive contamination. Phytoremediation was removed from consideration because of these two disadvantages.

Soil washing was evaluated for SWMU 21-011(k) because it has been successfully employed to remove heavy metals from contaminated soils. However, cesium presents a particular challenge to this technology because of its nature to bind tightly to soils. The ability of this technology to effectively and economically remove cesium from soil has not been demonstrated on a full-scale basis. Given the uncertainty of this technology to effectively remove cesium, this technology was removed from consideration.

4.4.1 Solidification Bench Scale Study

Bench-scale (laboratory-scale) testing to develop a soil solidification grout mix for the tuff and soil (including sediment) material was performed to identify the most appropriate grout formulation for long-term solidification and on-site burial of the materials.

Solidification grout mix testing was performed on soil and tuff samples collected from 8 locations and a range of activity levels at the site (Figure 4.4-1). Six soil samples and four tuff samples were collected for use in the bench scale testing. Five of the six soil samples were composited together at the laboratory for mix-design testing, as were the four tuff samples. Compositing of the soil samples and compositing of the tuff samples was performed to achieve a more representative material for the mix-design testing. The remaining soil sample, which had much higher levels of radionuclides, was used alone as a most-conservative sample for mix-design testing. An additional 60/40 mixture of tuff was tested using extra soil and tuff composites to determine if mixing of the soils during field operations would be an option and if it would improve the properties of the final stabilized material.

A total of eight reagent mixtures were tested on composite samples of tuff, soil, and a 60/40 mixture of soil and tuff. Reagents added to the soil, tuff, or 60/40 mixture were Portland cement, sodium bentonite, and sodium silicate in different proportions. The reagents and mixtures are similar to those used at other similar stabilization projects within the DOE complex. Results of the testing indicate the 60/40 soil and tuff mixture combined with 10 percent (by weight) Portland cement and 3 percent (by weight) sodium bentonite consistently performed better than any of the other mixtures tested (LANL 2002, 72638).

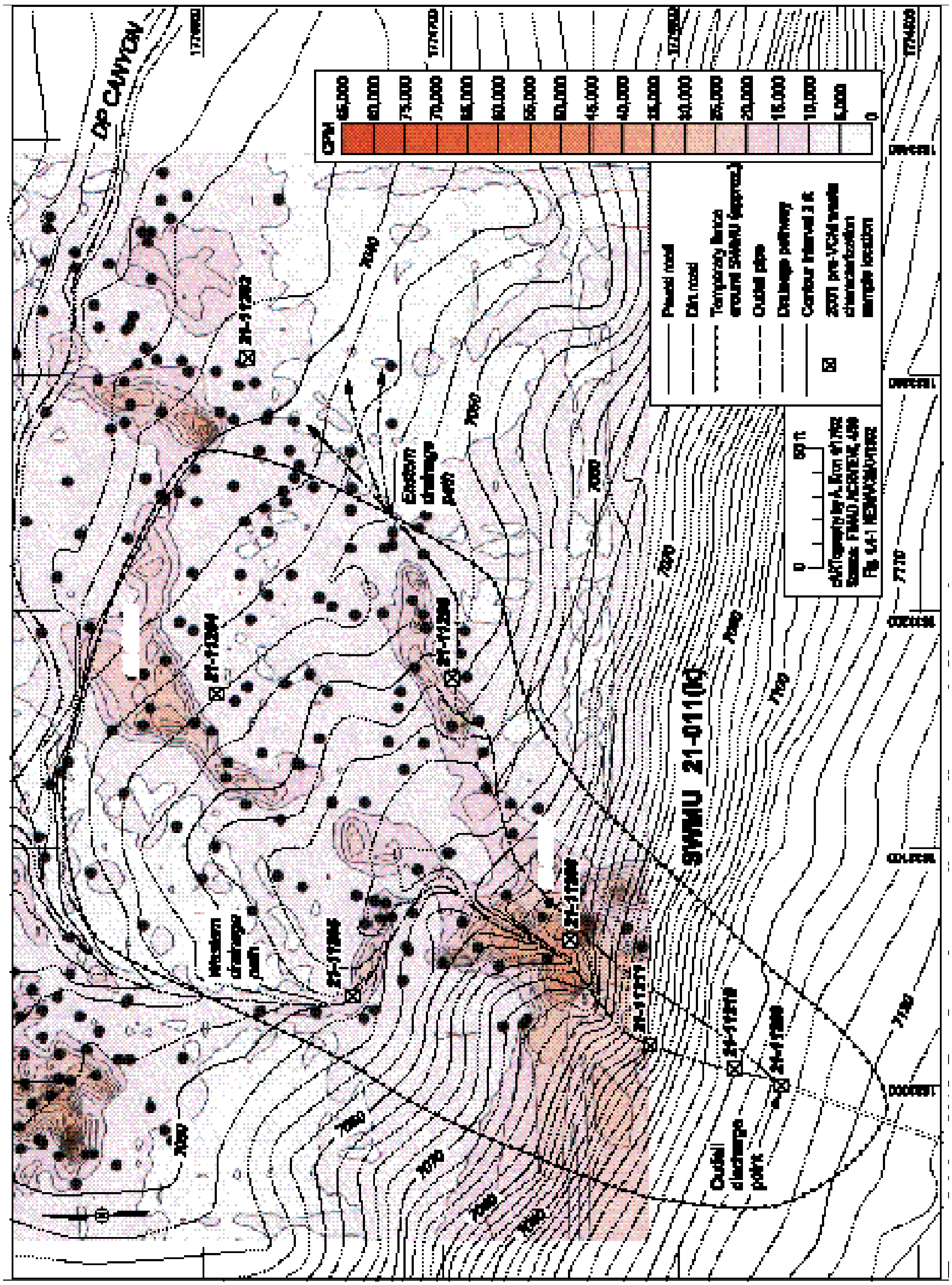

Figure 4.4-1. 2001 bench scale sampling locations and Chemrad survey

4.4.2 Remedial Approach

Following the readiness review, mobilization and site preparation activities will commence. Mobilization activities will include the delivery of site trailers, materials, and heavy equipment. Site preparation activities will include: set-up of site trailers; clearing and grubbing of all excavation areas and the process area; survey and staking of excavation areas, the process area, stabilization cell, etc.; construction of site support zones and process area; installation of sanitary facilities; tree removal and chipping; improvement and extension of existing haul road; fence removal; installation of temporary fencing; installation of erosion control measures; and the installation of two air monitoring stations.

The drainline from the two treatment tanks (Tanks 21-112 and 21-113) to the outfall ditch at the southern end of the SWMU will be removed (Figure 4.4-2). This 4-in. diameter, cast iron section of drainline extends 80 ft from the south side of the North Perimeter Road to a discharge point just below the canyon rim. The soil above the pipe will be excavated, the pipe will be removed, and the excavated trench will be backfilled following collection of verification samples as described in Section 5.

Concurrent with the drainline removal, the process area will be prepared east of the access road. A pugmill will be set-up in this area The pugmill is the mechanical mixing device that will be used to combine the soil, tuff and reagents into a homogeneous grout mass to be placed in the onsite excavation. The process area will also provide space for stockpiles of soil and a load out area for loader and dump truck operation. The pugmill (Rapidmix 400) will provide thorough, high-speed, high-shear mixing. This plant is designed to generate very little dust during operation.

Construction of a below-grade stabilization cell for burial of the solidified materials will proceed concurrently with the excavation and solidification of soil/sediment, and tuff with elevated activity. The stabilization cell will be located near the center of the site (Figure 4.4-3). The west end of the stabilization cell will have a ramp built at a 5:1 slope (Figure 4.4-4) to allow truck and equipment access for the placement of slidified material.

Areas of elevated activity to be excavated will be surveyed and staked. As these areas are excavated, real-time radiological screening combined with real time mapping of gross gamma radiation will be used to determine whether enough media has been removed to achieve the established clean-up levels. Excavated soil/sediment and tuff will be staged at the process area. Confirmation sampling will then be conducted, prior to installation of the cover, in accordance with Section 5.0 Confirmation Surveys and Sampling.

Contaminated soil/sediment and tuff will be composited at a ratio of 60/40 respectively. Contaminated material from the composite stockpile will then be sized for processing in the pugmill. Solidification reagents (cement and bentonite) will be loaded into the reagent bins of the pugmill. A water truck will provide water to the site for filling the pugmill water tanks. Composite material will be loaded into the pugmill using a loader. The pugmill is completely automated and will be adjusted to batch proportions of reagents, water, and contaminated composite material in accordance with the mix design. The maximum solidification rate will be 20 yd^3 per hour or 120 yd^3 per day. QA samples will be collected from the material exiting the pugmill. Specific testing parameters to verify solidification requirements will be detailed in the Construction Quality Control Plan and the results will be documented in the VLM Completion Report.

ESH-17 will operate two high-volume air samplers during onsite activities and will monitor appropriate air quality parameters.

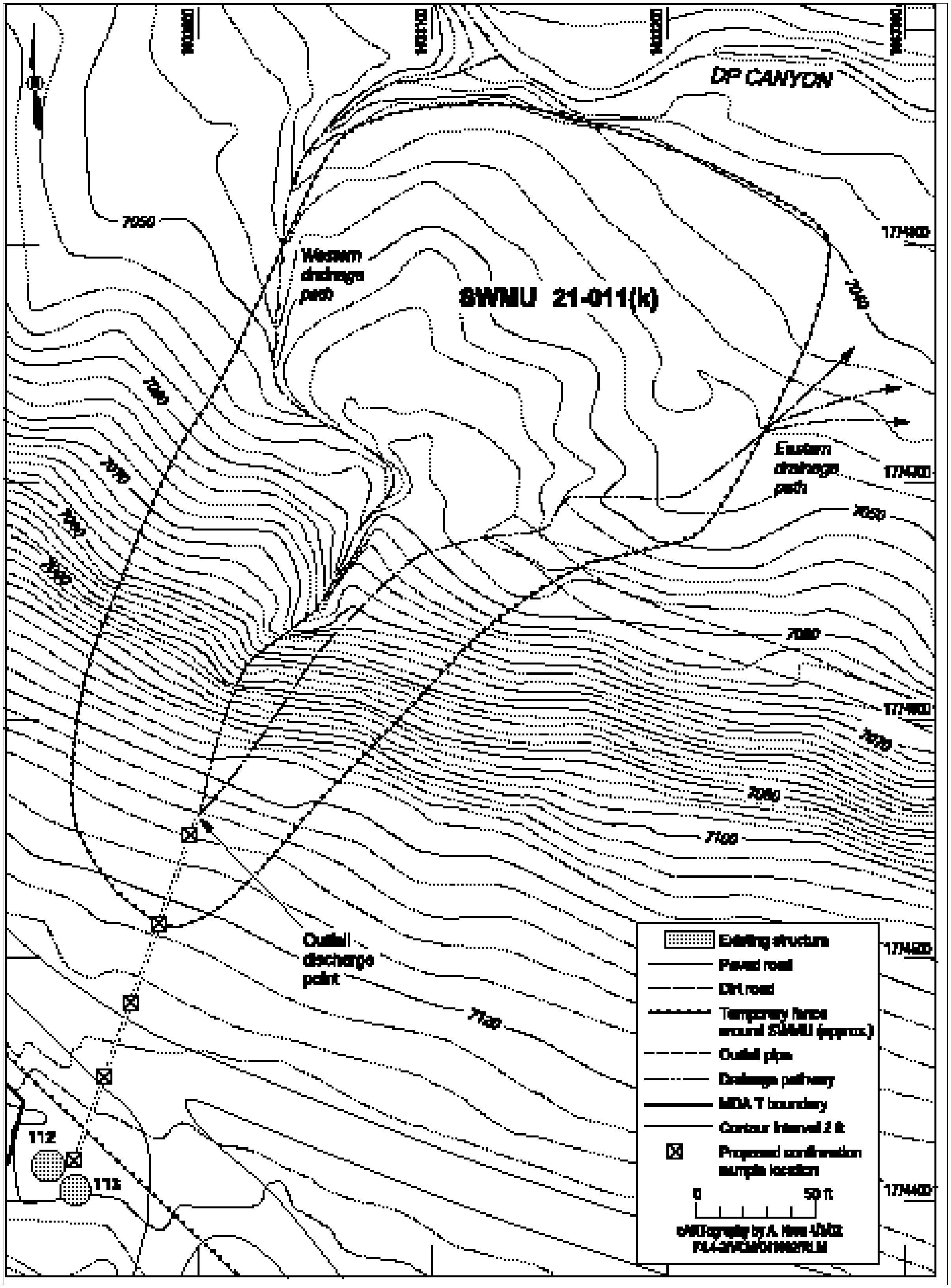

Figure 4.4-2 Outfall pipe to be removed and proposed confirmation sampling locations.

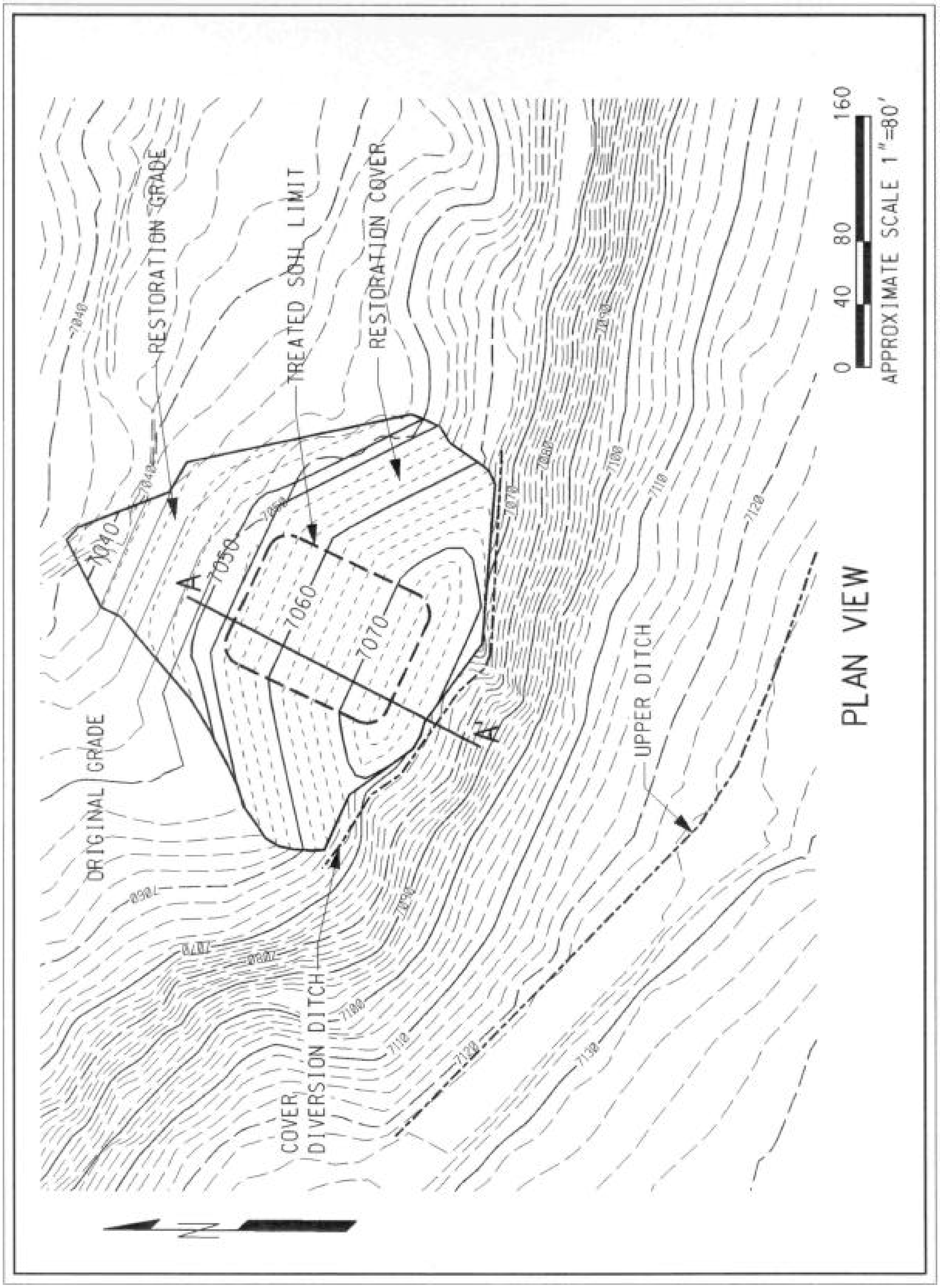

Figure 4.4-3 Location of stabilization cell

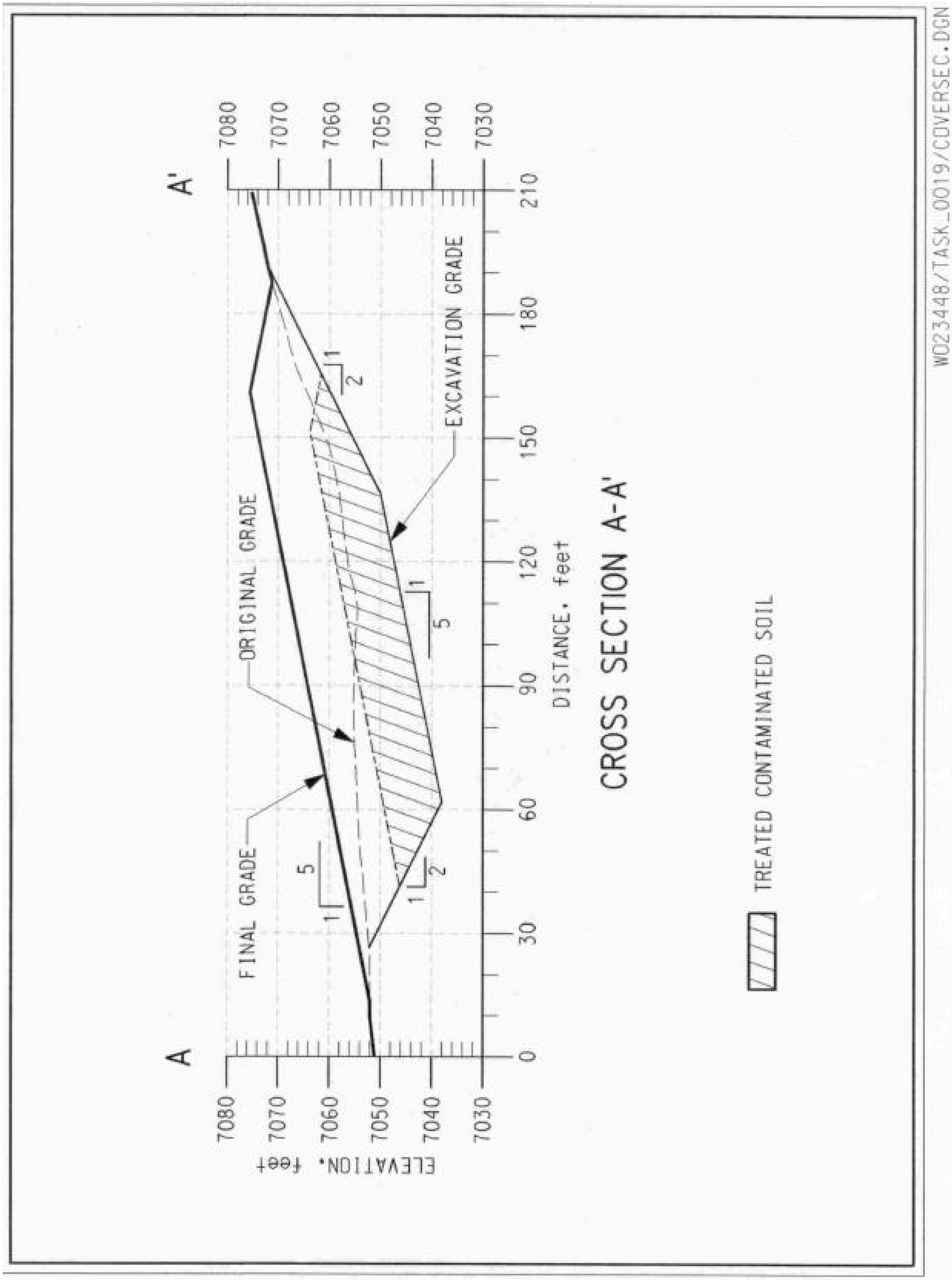

Figure 4.4-4 West end of stabilization cell with ramp

A small dump truck will be used to transfer the solidified material from the process area to the stabilization cell for placement. Solidified material will be spread across the bottom of the cell in lifts and compacted.

Following excavation and treatment activities, project personnel will decontaminate the pugmill and all earth-moving equipment. Residual media adhering to equipment will be removed using dry decontamination methods including the use of wire brushes and scrapers (WGII SOP 1.08 Rev 1). If necessary, final equipment decontamination will be performed on a temporary wash pad with a high-density polyethylene (HDPE) liner. Cleaning solutions and wash water will be recycled or collected for proper disposal. All parts of the equipment, including the undercarriage, wheels, tracks, chassis, and cab will be thoroughly cleaned. Air filters on equipment operating in the exclusion zone will be considered contaminated and will be removed and replaced before equipment leaves the site. A high-pressure sprayer along with long handled brushes and rods will be used to effectively remove contaminated material from equipment. Equipment will be surveyed by Environmental Safety and Health (ESH)-1 Radiological Control Technicians (RCT) prior to being released from the site.

4.4.3 Site Restoration

Upon completion of removal and solidification activities, site restoration will be implemented. This will involve the clearing and grubbing of areas where soil is to be placed, preparing the subgrade for placement of additional soil cover, import and placement of approximately 4000 yd^3 of soil on the hillside, and revegetation of the site. This includes areas excavated in earlier soil removal activities and all areas excavated during this corrective measure.

Approximately 4,000 yd^3 of borrow material will be transported to the site for placement. Borrow material will be placed in lifts and compacted. All grades will be finished in conformance with the lines and grade on the plans. Permanent run-on controls will be installed at the south end of the site and above the solidified material to limit erosion from the site. The permanent run-on controls will consist of water diversion ditches, one located at the top of the slope to prevent surface water from running onto the slope, and one located directly above the solidified material to prevent any surface water from draining onto the site.

Once grading is complete, revegetation activities will commence. Revegetation activities will conform to project specifications to be prepared by a landscape architect licensed in the state of New Mexico. Following revegetation of the disturbed areas, mulch from clearing and grubbing activities will be applied to the site.

Seeded areas will be maintained until a well-developed vegetative cover is established.

5.0 CONFIRMATION SURVEYS AND SAMPLING

5.1 Confirmation Sampling Below SWMU 21-011(k) Outfall Pipe

At a minimum, five locations will be sampled below the outfall line leading to SWMU 21-011(k). Samples will be collected from two depths (0 to 12 in. and 24 to 36 in. below the bottom of the removed pipe). Samples will be analyzed by gamma spectroscopy (Cs-137 and Am-241), and for strontium-90 and isotopic plutonium at a fixed laboratory and screened for gross alpha, beta and gamma radiation for DOT shipping purposes. One sample location each will be located at the joint nearest the north and south ends of the removed line. The remaining three sample locations will be distributed along the length of the line. Gamma screening will be conducted along the length of the line. Sample locations may be biased to areas of elevated gamma radiation identified during the screening or sample locations added as appropriate.

Much of the line to be removed is beneath the roadbed leading to the TSTA facility. Since this is the sole access road to this operating nuclear facility, only the above samples will be collected. The need to remove any contaminated soils beneath the outfall pipe or additional sampling required to define nature and extent of contamination will be determined after review of the fixed laboratory analytical results and in coordination with the TSTA facility.

5.2 Confirmation Surveys and Sampling of Soil Removal Areas

After the elevated activity areas have been remediated but before restoration occurs, verification samples will be collected at a rate of at least one per 25 yd^2 of remediated areas. At least one surface sample will be collected from each discrete remediated area, even if it is much smaller than 25 yd^2. A minimum of one sample per 500 yd^2 of areas not requiring remediation will be collected at random. Verification samples will be screened in the on-site trailer and then sent to a fixed lab for further characterization. Fixed lab analysis will be performed by gamma spectroscopy (Cs-137 and Am-241), strontium-90 and isotopic plutonium.

A walkover gross gamma survey of the entire SWMU prior to restoration will be performed to obtain count rates across the site at a rate of at least 1 per yd^2 of affected area. This survey is to include all affected areas as well as the particular locations where verification samples were collected.

The data quality objective for the walkover survey is that the standard deviation of the count rate data should not exceed 2% of the count rate for locations where the cesium-137 activity is estimated to be 150 pCi/g. This data quality objective will ensure that the gross gamma data will be precise enough to be useful for decision making at locations where soil concentrations could possibly approach the target level.

After the cover is placed and compacted on top of the stabilized soil, a verification survey will be conducted to confirm the shielding action of the cover. The confirmation screening survey will consist of a walkover gross gamma survey. Locations of detections above the target concentration of 150 pCi/g will be sampled for gamma spectrometry in the field counting trailer.

Data from both surveys will be used to derive radionuclide concentrations to demonstrate that the site meets target levels and that the DOE 5400.5 elevated activity criterion is satisfied. Attainment of these objectives will be documented in the VCM Completion Report for SWMU 21-011(k).

5.3 Long-Term Monitoring

A thermoluminescent dosimeter (TLD) survey will be conducted annually as part of an ongoing monitoring program at the site. TLDs are routinely used to monitor personnel exposure and can be used for stationary monitoring points. Approximately 30 TLD badges will be obtained from ESH-17 and placed onsite for one year. Sample locations will be chosen to represent the anticipated range of gamma radiation levels on site. Proposed sample locations and data quality objectives will be detailed in the execution plan which will be developed for the site activities.

Routine inspections of the engineered site restoration and BMPs will be conducted on a frequency to be proposed in the VCM Completion Report. Periodic radiation surveys may also be conducted to ensure the design specifications of the corrective measure are being met.

Annual inspections of the restored areas will consist of a yearly inspection for the first five years after which the inspection requirements will be reviewed. A formal site inspection program will be initiated following site restoration to ensure long-term cover integrity. Inspections will be performed quarterly for the first three years and bi-annually thereafter. The vegetative cover will be inspected for vegetation loss, signs of improper surface drainage, and erosion, including sheet flow, rill, and channelized gully erosion. Areas of the vegetative cover that exhibit a loss of greater than six square feet or repetitive voids greater than two square feet amounting to more than 10 percent of any area will be reseeded. Stormwater controls will be examined to ensure run-on is prevented and diverted away from the site. The cover will also be inspected for excessive differential settlement and subsidence. Depressions will be filled with cover soil and reseeded. Site postings will be inspected to ensure that they prevent unauthorized disturbance of the stabilized material.

6.0 WASTE MANAGEMENT

6.1 Estimated Types and Volumes of Waste

Five separate waste streams are anticipated from this VCM. The waste streams, expected waste types, and volumes are summarized in Table 6.1-1. Waste stream descriptions, including the principal components of the waste and any uncertainties in volume calculations, are described in the paragraphs that follow.

Table 6.1-1
Waste Streams, Types, and Volumes at SWMU 21-011(k)

Waste Stream	Waste Type/Form	Anticipated Volume
Contact waste (PPE, plastic sheeting, disposable sampling supplies, dry decontamination waste, etc.)	Low-level radioactive waste; solid, compactible	30 yd3 (precompacted)
Decontamination solutions	Low-level radioactive waste; liquid	1,000 gallons
Vegetation (brush, small-diameter trees, scrub oak)	Low-level radioactive waste; solid	40 yd3
Metal pipe	Low-level radioactive waste; solid, noncompactible	5 yd3
Municipal refuse, uncontaminated trash and debris (cardboard, paper, plastic, etc.)	Municipal solid waste (MSW); solid	25 yd3

Contact waste. This waste stream will include various types of disposable debris including personal protective equipment (gloves, booties, filter cartridges); plastic sheeting (e.g., liners, tarps and contamination control covers), sampling supplies such as plastic scoops, plastic bags, jars, and filters; and dry decontamination waste. These wastes have the potential to be become contaminated through direct contact with contaminated environmental media. Characterization of this waste will be determined through soil contaminant concentrations and from direct radiological surveys. The volume of contact waste will be kept to a minimum by decontaminating any reusable items that come into contact with the contaminated environmental media.

Decontamination solutions. This waste stream will consist of liquids generated from on-site decontamination of process equipment; tools; excavation equipment, vehicles; sampling equipment; and personnel. The volume of decontamination solutions will be minimized through the use of “dry” techniques and by reusing any in-process wastewater in the soil stabilization process.

Decontamination solutions will be characterized through direct sampling in order to demonstrate compliance with Waste Acceptance Criteria (WAC) at the TA-50 Radioactive Liquid Waste Treatment Facility (RLWTF).

Vegetation. Brush, small trees, and scrub oak will be cleared from the site during site preparation activities. This material will be screened for radiological activity and used, as appropriate, as restoration material.

Metal pipe. A 4-inch diameter, cast iron drainline from the two wastewater treatment tanks will be removed and packaged as low-level radioactive waste. This waste stream will be characterized by survey of direct and removable contamination on the drainline. All surveys will be performed by a qualified RCT.

Municipal refuse. This waste stream will include miscellaneous uncontaminated cardboard, plastic, and paper generated during the project. Administrative controls will be established to minimize the introduction of items (e.g., packaging materials) into the exclusion zone and/or radiological control areas. As much as practicable, plastic sheeting (e.g., tarps, liners, and contamination control covers) and reusable supplies will be decontaminated, surveyed and released by a qualified RCT. All recyclable materials will be segregated from this waste stream prior to disposal.

6.2 Method of Management and Disposal

This section describes the planned methods of managing the waste from the time of generation to final disposal.

Contact waste. This waste will be collected in 55-gallon plastic bags and deposited into metal collection boxes (approx. 90 cu ft capacity) for interim storage. The metal boxes will remain in an onsite radioactive waste staging area located until filled and prepared for transport. The contact waste will then be shipped to the low-level waste (LLW) Compaction Facility at TA-54 Area G for disposal.

Decontamination solutions. Wastewater from the onsite decontamination pad will be pumped into plastic tuff tanks (330-gal capacity) and stored in secondary containment within a liquid radioactive waste staging area. Liquid waste samples will be collected and composited for characterization purposes. Radioactively contaminated liquids will be transported in the tuff tanks to the TA-50 RLWTF for disposal.

Vegetation. This waste stream will be cleared from the site, loaded into 20 yd^3 roll-off containers and staged in a radioactive waste storage area. The vegetation will be transported to TA-54, Area G for disposal.

Metal pipe. The cast iron drainline will be placed into a lined roll-off container and staged in an onsite radioactive waste storage area. This waste stream will be disposed at TA-54, Area G.

Municipal refuse. Uncontaminated trash will be collected daily in plastic drum liners and staged onsite in a solid waste storage area. This waste will be disposed at the Los Alamos County Landfill.

7.0 PROPOSED SCHEDULE AND UNCERTAINTIES

The fieldwork portion for this VCM is expected to begin on July 1, 2002 and is anticipated to end by September 24, 2002 (Table 7.0-1). Ten working days have been allotted for a site readiness review, training, and mobilizing. Ten working days have been allotted for site preparation activities. Twenty-five working days have been scheduled for excavation of contaminated material, treatment, and confirmation sampling. Fifty working days have been allotted for waste disposal activities. Ten working days have been allotted for site restoration activities. Demobilization activities are schedule to take 7 working days. The VCM Completion Report will be prepared and submitted to the NMED Hazardous Waste Bureau (HWB) in March 2003.

Table 7.0-1
VCM Field Work Schedule

Activity	Workday Duration	Start	Finish
Readiness review/mobilization	10 days	July 1, 2002	July 12, 2002
Site Preparation	10 days	July 15, 2002	July 26, 2002
Excavation, treatment, and confirmation sampling	25 days	July 29, 2002	August 30, 2002
Waste management/disposal	50 days	July 15, 2002	September 20, 2002
Site restoration	10 days	September 2, 2002	September 13, 2002
Demobilization	7 days	September 16, 2002	September 24, 2002
Approximate Working Days	62 days	July 1, 2002	September 24, 2002

8.0 REFERENCES

The following list includes all references cited in this appendix. Parenthetical information following each reference provides the author, publication date, and the ER identification (ID) number. This information also is included in the citations in the text. ER ID numbers are assigned by the Laboratory's ER Project to track records associated with the Project. These numbers can be used to locate copies of the actual documents at the ER Project's Records Processing Facility and, where applicable, with the ER Project reference library titled "Reference Set for Material Disposal Areas, Technical Area 54."

Copies of the reference library are maintained at the NMED Hazardous Waste Bureau; the DOE Los Alamos Area Office; United States Environmental Protection Agency, Region 6; and the ER Project Material Disposal Areas Focus Area. This library is a living collection of documents that was developed to ensure that the administrative authority has all the necessary material to review the decisions and actions proposed in this document. However, documents previously submitted to the administrative authority are not included.

DOE (US Department of Energy) 1988. "DOE Headquarters Environmental Survey of Los Alamos National Laboratory." (DOE 1988, 15363)

DOE (US Department of Energy)1990. "Radiation Protection of the Public and Environment," DOE Order 5400.5. (DOE 1990, 58980.1)

EPA (US Environmental Protection Agency), April 10, 1990. "Region 6 Hazardous Waste Permit (Hazardous and Solid Waste Amendments)," Permit NM0890010515. (EPA 1990, 01585.2)

EPA (US Environmental Protection Agency), September 1, 2000. "EPA Region 6 Human Health Medium-Specific Screening Levels, US EPA Region 6." (EPA 2000, 68410.1)

Langmuir, D., 1997. *Aqueous Environmental Geochemistry*, Prentice-Hall, Inc., Upper Saddle River, New Jersey. (Langmuir 1997, 56037)

LANL (Los Alamos National Laboratory), May 1991. "TA-21 Operable Unit RFI Work Plan for Environmental Restoration", Los Alamos National Laboratory report LA-UR-91-962, Los Alamos, New Mexico. (LANL 1991, 07528.1)

LANL (Los Alamos National Laboratory), February 28, 1994. "Phase Report 1C, TA-21 Operable Unit RCRA Facility Investigation, Outfalls Investigation," Los Alamos National Laboratory report LA-UR-94-228, Los Alamos, New Mexico. (LANL 1994, 31591.1)

LANL (Los Alamos National Laboratory), 1994. "Phase Report Addendum 1B & 1C Operable Unit 1106 RCRA Facility Investigation Phase Report," Los Alamos National Laboratory report LA-UR-94-4360, Los Alamos, New Mexico. (LANL 1994, 52350.1)

LANL (Los Alamos National Laboratory), September 1, 1996. "Interim Action Plan for Potential Release Site 21-011(K) Discharge System Field Unit 1, September 1996," Los Alamos National Laboratory report LA-UR-96-1609, Los Alamos, New Mexico. (LANL 1996, 54790.2)

LANL (Los Alamos National Laboratory), 1997. "Interim Action Report for Potential Release Site 21-011(k) Discharge System Field Unit 1, April 1997," Los Alamos National Laboratory report, Los Alamos, New Mexico. (LANL 1997, 55648.2)

LANL (Los Alamos National Laboratory), August 26, 1999. "Evaluation of Sediment and Alluvial Groundwater in DP Canyon, Reaches DP-1, DP-2, DP-3, and DP-4," Los Alamos National Laboratory document LA-UR-99-4238, Los Alamos, New Mexico. (LANL 1999, 63915)

LANL (Los Alamos National Laboratory), December 1, 1999. "Screening Level Ecological Risk Assessment Methods," Rev.1, Los Alamos National Laboratory report LA-UR-99-1405, prepared by R. Ryti, E. Kelly, M. Hooten, G. Gonzales, and L. Soholt, ER Project A3 Focus Area, Los Alamos National Laboratory, Los Alamos, New Mexico. (LANL 1999, 64783.1)

LANL (Los Alamos National Laboratory), January, 2001. "Release/Discharge Notification," Los Alamos National Laboratory document, Permit Number NM0028355, Los Alamos, New Mexico. (LANL 2001, 72667)

LANL, March 2001. "Derivation and Use of Radionuclide Screening Action Levels, LANL Environmental Restoration Project," Los Alamos National Laboratory report LA-UR-01-990, Los Alamos, New Mexico. (LANL 2001, 69683.1)

LANL (Los Alamos National Laboratory), October 2001. Environmental Restoration Project Communication Record, Los Alamos, New Mexico. (LANL 2001, 70217)

LANL (Los Alamos National Laboratory), March 2002. "ECORISK Database (Release 1.4), ER package #186," Environmental Restoration Project, Los Alamos, New Mexico. (LANL 2002, 72802)

LANL (Los Alamos National Laboratory), April 2002. "Human Health Risk-Based Screening Methodology," Los Alamos National Laboratory report LA-UR-02-1563, Los Alamos, New Mexico. (LANL 2002, 72639)

LANL (Los Alamos National Laboratory), March 2002. "Stabilization of the Contaminated Tuff and Sediment at the Los Alamos National Laboratory," prepared by IT Corporation for the Environmental Restoration Project, Los Alamos, New Mexico. (LANL 2002, 72638)

NMED (New Mexico Environment Department), December 18, 2000. "Technical Background Document for Development of Soil Screening Levels (Volume I Soil Screening Guidance Technical Background Document)," New Mexico Environment Department Hazardous Waste Bureau and Ground Water Quality Bureau Voluntary Remediation Program, Santa Fe, New Mexico. (NMED 2000, 68554.1)

Ryti, R., and P. Longmire, September 22, 1998. "Inorganic and Radionuclide Background Data for Soils, Canyon Sediments, and Bandelier Tuff at Los Alamos National Laboratory," Los Alamos National Laboratory report LA-UR-98-4847, Los Alamos, New Mexico. (Ryti and Longmire 1998, 59730)

Appendix A

List of Acronyms and Glossary

APPENDIX A LIST OF ACRONYMS AND GLOSSARY

BMP	best management practice
COPC	chemical of potential concern
DOE	US Department of Energy
EPA	US Environmental Protection Agency
ER	environmental restoration
ESL	ecological screening level
ESH	environment, safety, and health
FIMAD	Facility for Information Management, Analysis, and Display
HSWA	Hazardous and Solid Waste Act
HWB	Hazardous Waste Bureau
IA	interim action
LANL	Los Alamos National Laboratory
LLW	low-level waste
MDA	material disposal area
NMED	New Mexico Environment Department (New Mexico Environmental Improvement Division before 1991)
NPDES	National pollutant discharge elimination system
OU	operable unit
PCB	polychlorinated biphenyl
PPE	personal protective equipment
RCRA	resource Conservation and Recovery Act
RFI	RCRA facility investigation
RLW	radioactive liquid waste
RLWTF	radioactive liquid waste treatment facility
SALs	screening action levels
SOP	standard operating procedure
SVOC	semivolatile organic compound

SWSC	sanitary wastewater system consolidation
SWMU	solid waste management unit
TA	technical area
TAL	target analyte list (EPA)
TCLP	toxicity characteristic leaching procedure
T & E	threatened and endangered
TSD	treatment, storage, disposal
VCA	voluntary corrective action
VCM	voluntary corrective measure
VOC	volatile organic compound
VCP	vitrified clay pipe
WAC	waste acceptance criteria
WWTP	wastewater treatment plants

Glossary

Baseline Risk Assessment—Anthropogenic concentrations of a given chemical in the soil associated with Laboratory and/or commercial activities or processes that may not be related to source material(s) or a release(s) from within a potential release site. Examples of baseline levels are nuclear fallout and organic chemicals associated with urban activities.

Department of Energy (DOE)—Federal agency that sponsors energy research and regulates nuclear materials for weapons production.

DOE ORDER 5400.5, HOT SPOTS—"If the average concentration in any surface or below-surface area less than or equal to 25 m^2 exceeds the limit or guideline by a factor of $(100/A)^{0.5}$ [where A is the area of the region in which concentrations area elevated]. Limits for "hot-spots" shall also be developed and applied. Procedures for calculating these hot-spot limits, which depend on the extent of the elevated local concentrations, are given in DOE/CH-8901. In addition, reasonable efforts shall be made to remove any source of radionuclide that exceeds 30 times the appropriate limit for soil, irrespective of the average concentration in the soil."

Environmental Protection Agency (EPA)—Federal agency responsible for enforcing environmental laws. While state regulatory agencies may be authorized to administer some of this responsibility, the EPA retains oversight authority to ensure protection of human health and the environment.

Groundwater—Water in a subsurface saturated zone; water beneath the regional water table.

Evapotranspiration—The combined *discharge* of water from the earth's surface to the atmosphere by evaporation from lakes, streams, and soil surfaces, and by transpiration from plants.

Medium—Any media capable of *absorbing* or *transporting* constituents. Examples of media include *tuffs*, soils and *sediments* derived from these *tuffs*, surface water, *soil water*, *groundwater*, air, structural surfaces, and debris.

Operable Unit—At the Laboratory, one of 24 areas originally established for administering the ER Project. Set up as groups of *potential release sites*, the OUs were aggregated based on geographic proximity for the purpose of planning and conducting *RCRA facility assessments* and *RCRA facility investigations*. As the project matured, it became apparent that 24 were too many to allow efficient communication and to ensure consistency in approach. Therefore, in 1994, the 24 OUs were reduced to six administrative "field units."

Potential Release Site—Refers to potentially contaminated sites at the Laboratory that are identified either as *solid waste management units (SWMUs)* or *areas of concern* (AOCs). SWMU refers to *SWMUs* and AOCs collectively.

RCRA facility investigation (RFI)—The investigation that determines if a release has occurred and the nature and extent of the contamination at a hazardous waste facility. The RFI is generally equivalent to the remedial investigation portion of the Comprehensive Environment Response, Compensation, and Liability Act (CERCLA) process.

Resource Conservation and Recovery Act (RCRA)—The Solid Waste Disposal Act as amended by the Resource Conservation and Recovery Act of 1976. (40 CFR 270.2)

Solid Waste Management Unit— Any discernible unit at which *solid wastes* have been placed at any time, irrespective of whether the unit was intended for the management of *solid or hazardous waste*. Such units include any area at a facility at which *solid wastes* have been routinely and systematically *released*. This definition includes regulated units (i.e., landfills, surface impoundments, waste piles, and land *treatment* units) but does not include passive leakage or one-time spills from production areas and units in which wastes have not been managed (e.g., product storage areas).

Radionuclide— A nuclide (species of atom) that exhibits radioactivity.

Remediation—The process of reducing the concentration of a contaminant (or contaminants) in air, water, or soil media to a level that poses an acceptable risk to human health and the environment; the act of restoring a contaminated area to a usable condition based on specified standards.

Runoff—The portion of the precipitation on a drainage area that is discharged from the area either by sheet flow or adjacent stream channels.

Run-on—Surface water flowing onto an area as a result of runoff occurring higher up the slope.

Site characterization—Defining the pathways and methods of migration of the hazardous waste or constituents, including the media affected, the extent, direction and speed of the contaminants, complicating factors influencing movement, concentration profiles, etc. (U.S. Environmental Protection Agency, May 1994. “RCRA Corrective Action Plan, Final,” Publication EPA-520/R-94/004, Office of Solid Waste and Emergency Response, Washington, DC)

Solid waste management unit (SWMU)—Any discernible unit at which solid wastes have been placed at any time, irrespective of whether the unit was intended for the management of solid or hazardous waste. Such units include any area at a facility at which solid wastes have been routinely and systematically released. This definition includes regulated units (i.e., landfills, surface impoundments, waste piles, and land treatment units) but does not include passive leakage or one-time spills from production areas and units in which wastes have not been managed (e.g., product storage areas).

Standard operating procedure (SOP)—A document that details the method for an operation, analysis, or action with thoroughly prescribed techniques and steps, and is officially approved as the method for performing certain routine or repetitive tasks.

Target analyte—An element, chemical, or parameter, the concentration, mass, or magnitude of which is designed to be quantified by use of a particular test method.

Technical area (TA)—The Laboratory established technical areas as administrative units for all its operations. There are currently 49 active TAs spread over 43 square miles.

Topography—The physical configuration of the land surface in an area.

Treatment—Any method, technique, or process, including elementary neutralization, designed to change the physical, *chemical*, or biological character or composition of any *hazardous waste* so as to neutralize such waste; recover energy or material resources from the waste; or so as to render such waste nonhazardous or less hazardous; safer to *transport*, store, or dispose of; or amenable for recovery or storage; or reduced in volume.

Tuff—A compacted deposit of volcanic ash and dust that contains rock and mineral fragments accumulated during an eruption.

Vadose zone—The unsaturated zone. Portion of the subsurface above the regional water table in which pores are not fully saturated.